Technical Report 669

Application of Transfer Forecast Methods to Armor Training Devices

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The research described in this report was performed as part of the ARI program to validate and refine TRAINVICE methodology. The specific objectives were as follows:

1. Determine how reliably subject matter experts can make judgments needed to compute TRAINVICE estimates.
2. Determine how valid the estimates are.
3. Recommend how TRAINVICE judgments and estimates can be made more valid, reliable, and efficient.

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FOREWORD

This report is part of a research program by the Army Research Institute for the Behavioral and Social Sciences (ARI) to develop analytic tools for estimating training device effectiveness. To date, four analytic models under the heading "TRAINVICE" have been developed, but their validity is still in question because predictor and criterion measurements available for validation studies are few. The authors of this report were able to get these measurements from transfer-of-training data gathered on four training devices during the operational testing of an MK-60 gunnery trainer, the Videodisc Integrated Gunnery Simulator (VIGS). The findings indicate that TRAINVICE scores were reasonably consistent for each particular model between raters. However, particular components variables of each model showed low agreement between raters. The authors suggest that future research on transfer forecast models increase the reliability of the predictor measures, improve the criterion measurement environment, and determine the scale properties of the models.

EDGAR M. JOHNSON
Technical Director

APPLICATION OF TRANSFER FORECAST METHODS TO ARMOR TRAINING DEVICES

EXECUTIVE SUMMARY

Requirement:

Forecasting transfer from examinations of device and other training-system characteristics has been the subject of ARI-sponsored research for several years. This report is part of an ARI program to develop analytic tools for estimating training device effectiveness.

Procedure:

Research was performed to assess the reliability and validity of a set of tools called TRAINVICE. TRAINVICE workbooks were prepared, and the procedures were applied to four training devices. Empirical data were collected in order to relate the predictor estimates from TRAINVICE to the criterion measures (transfer data).

Findings:

The overall TRAINVICE scores were reasonably consistent between raters for each particular model. However, examining the component variables of each model shows low agreement for particular classes of variables within models. These variables require the more subjective judgments.

The results of the data collection indicate the difficulties inherent in collecting criterion data. The lack of control over the collection yielded data without variance.

Utilization of Findings:

Future research on transfer forecast models must increase the reliability of the predictor measures, improve the criterion measurement environment, and determine the scale properties of the models.

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This report is part of an Army Research Institute program to develop analytic tools for estimating training device effectiveness. Research was performed to assess the reliability and validity of a set of tools called TRAINVICE. TRAINVICE workbooks were prepared and the procedures applied to four training devices. Empirical data were collected in order to relate the predictor estimates from TRAINVICE to the criterion measures. Extensive information was gathered on how consistently each TRAINVICE version and sub-scale of each version is applied. Problems were uncovered with application and improved procedures suggested for using the methods.

Background

The training device acquisition process begins when a training need is identified to support a new weapon system or to solve a training deficiency for an existing system. During the phase of concept formulation, developers consider tasks to be trained, trainee characteristics, alternative hardware configurations, simulation technology, and costs. Several alternative device concepts may be considered. The acquisition process depends on the cost level, existence of commercially available devices, developmental risks, and, for a developing weapon system, the progress of the parent system through its acquisition process.

In general, data available early in the device acquisition process are subjective (e.g., judgments of subject matter experts), low in resolution, and qualitative. These low-quality data are all that are available at the very time that the technological risks are high (e.g., early decisions may guide the device to or from high cost alternatives that do or do not use the technological state of the art). Data available later in the device acquisition process are more objective, quantitative, and empirical.

However, even after the production of a device, empirical testing may be omitted because of prohibitive costs.

The combined cost of empirical research and scarcity of objective data during the acquisition process press the need for structured, quantifiable algorithms for predicting the degree to which training on devices and simulators transfers to the actual equipment. Forecasting transfer from examinations of device and other training-system characteristics has been the subject of ARI-sponsored research for several years. The Army has developed a family of predictive models known collectively as TRAINVICE. As Tufano and Evans indicate (1982), these four models represent "the most ambitious steps taken to date in the field of analytic evaluation" (p. 2). The original TRAINVICE model resulted from a review by Wheaton, Rose, Fingerman, Korotkin, and Holding (1976) of several methods for estimating the effectiveness of proposed training devices. They found the estimation procedures generally inadequate. A new forecast method was proposed (Wheaton, Fingerman, Rose, and Leonard, 1976) that predicted transfer of training based on the training variables (tasks, behaviors) and device variables (appropriateness, efficiency, effectiveness). This model is TRAINVICE I (TVI). As part of an effort to develop detailed guidance for user application, TVI was modified (PM-TRADE, 1979) and is referred to as TRAINVICE II (TVII).

Narva (1979) tried to make the transfer prediction more procedural and easier for Army analysts to use. He divided the procedures into those that answered three questions about the proposed training device. First, what is to be represented in the training device? "What" refers to the units of activity to be trained. Second, why is the unit of activity included? The reasons are training criticality and training difficulty. Third, how are the activities to be conveyed by the device, and how are they to be taught? The ways cover the physical and functional characteristics of the device. The functional characteristics were adapted from the Training Effectiveness and Cost Effectiveness Prediction (TECEP) procedure developed by the Navy's Training and Evaluation Group (Braby, Henry, Parris, and Swope, 1975). Narva's model is TRAINVICE III (TVIII). In an effort to develop a user

guidebook for applying TVIII, Swezey and Evans made additional revisions (1980). This approach is referred to as TRAINVICE IV (TVIV).

The four models share a common data collection method. As summarized by Tufano and Evans (1982),

> This method consists of a structured interrogation of a subject matter expert. As such, the models place a very high premium on the judgment of an expert. The method focuses decision-making on a specific set of issues for each task or part of a task. In the first of the TRAIN-VICE models, for example, one of the issues considered is the similarity between the equipment on a training device and that on the operational equipment to perform a particular subtask. This issue is further delineated into physical similarity (appearance, location, etc.) and functional similarity (amount of information flow between the human operator and the controls and displays) .... The judgments of the subject matter expert and the index of effectiveness rely on many assumptions, both theoretical and mathematical in nature. The theoretical assumptions include: (a) what is being predicted (e.g., a particular measure of transfer of training); and (b) which task and equipment variables have the predictive power to generate such a measure of effectiveness. The mathematical assumptions concern: (a) the manner in which all the values are combined; and (b) the numerical properties of the rating scales used to estimate those values (1982, p. 2)

Differences in assumptions are manifested in the models in several important ways. For example, the mathematical weight of each of the variables considered in the calculation of the indices are given different degrees of emphasis in each model. The procedures used to estimate the values for each component vary considerably from model to model. Moreover, the procedures used to calculate an index of effectiveness from the variable values are also very different in each model (Tufano and Evans, 1982, p. 1).

Rationale

Opportunities to try out the models, and to use tryout results to revise the models for improved prediction have, unfortunately, been limited. In some cases (Wheaton, et. al., 1976), predictor values were reliably estimated

but the opportunity for criterion data collection was absent. In other cases (Holman, 1979), the original model was revised without benefit of either predictor estimation or criterion measurement.

Mainly because of practical constraints (i.e., cost, availability of devices, parent equipment, subjects, and subject matter experts), the cases in which predictor and criterion measurement occur are few. Investigators have been forced by practical constraints to await opportunities in which both prediction and criterion measurement could be accomplished. An opportunity arose recently during the operational testing of an MK-60 gunnery trainer, the Videodisc Integrated Gunnery Simulator (VIGS).

Data were to be collected on transfer as a function of training which used the VIGS, as well as three alternative training devices. Since criterion and transfer data were to be collected in any event for training that used the devices, all that is required to test transfer-forecast models is to generate reliable estimates of predictor dimensions, and combine the estimates as prescribed by the models to generate transfer forecasts.

Objectives

The research described in this report was performed as part of the ARI program to validate and refine TRAINVICE methodology. The specific objectives were to:

(1) Determine how reliably subject matter experts (SME) can make the judgments needed to compute TRAINVICE estimates.

(2) Determine how valid the estimates are.

(3) Recommend how TRAINVICE judgments and estimates can be made more reliable, valid, and efficient.

METHOD-PREDICTORS

Four tasks were performed to determine how reliably SME make judgments needed to compute TRAINVICE estimates. The four tasks were (1) select devices, (2) select gunnery engagement, (3) prepare workbooks, and (4) perform ratings.

Select Devices

Four Armor gunnery training devices were selected and each model was applied. The devices were the MK-60 Gunnery Trainer (VIGS), the burst-on-target (BOT) trainer; the M55 laser tank gunnery trainer; and the subcaliber 5.56mm Brewster device (BRW).

MK-60 Gunnery Trainer (VIGS)

The MK-60 is a portable electronic training device designed to provide soldiers with realistic and effective target engagement skills training for both novice and experienced gunners. The trainer combines video disc and microcomputer technologies. The gunner sees targets through an optical system that combines the image with a projected reticle, tracks the target and fires. Computer generated graphics display hits, misses, and tracers in the gunner's sight-picture and an external monitor. Performance is assessed by the microcomputer and feedback given to the gunner on a black and white scorecard CRT at the gunner's console.

Burst-on-Target-Trainer (BOT)

The BOT uses simulated tank turret controls and a gunner's sight for operation. The trainer provides a target and reticle which move with respect to each other when the controls are actuated. The targets are various 35mm color slide transparencies of enemy tanks or vehicles and projected into the sight picture by a standard carousel projector mounted within the trainer. When the gunner is on target and fires the main gun, a flash of laser light simulates the round burst. The instructor can view the scene and has independent control of the burst position to simulate various trajectories.

M55 Laser Tank Gunnery Trainer

The M55 trainer is installed in the M60A1's M73/M219 machine gun mount. Each time the main gun is fired, the simulator provides a single burst of red light, visible through the optics. This lets the gunner accurately determine how well he is laying his gun sights and tracking the target. In addition, a supervising scorer can observe how accurately and proficiently the gunner is operating the tank's main weapon system. The trainer is used specifically to train on the proper techniques of:

- o laying sights on a target
- o tracking a target
- o firing the gun
- o visually adjusting the lay of the weapon on a target.

Subcaliber 5.56mm Brewster Device (BRW)

The BRW is a mounting device which permits use of the M16 rifle or M55 laser for subcaliber firing at reduced range. The device is used in conjunction with the scaled range target system and is wired to the control firing circuit and fired by the gunner's firing trigger.

Select Gunnery Engagement

A primary consideration during the planning phase of this project was to prevent the amount of material to be rated from overshadowing the issue of interest--the validity of the TRAINVICE models. For this reason, only one gunnery engagement task with its appropriate subtasks, controls, displays, knowledges, and skills was selected to be rated for each TRAINVICE model.

A stationary firing tank, moving target tank, precision-periscope engagement was selected. Four behaviors for a direct fire engagement using BOT were added to the eight gunner behaviors for that engagement. These four behaviors were derived from FM17-12, Tank Gunnery. Thus, the criterion gunnery engagement contains 12 analytically derived behavioral elements which are the subtasks in TVI and the task elements in TVII. The gunnery engagement with behavioral elements is shown at Figure

IDOC JOB OBJECTIVE 56
PLUS BOT

Precision, periscope, stationary firing tank, moving tank target (1200-1600) meters), SABOT, direct fire adjustment (BOT)

GUNNER BEHAVIORAL ELEMENTS

1. Gunner indexes ammunition.
2. Gunner turns on main gun switch.
3. Gunner announces IDENTIFIED.
4. Gunner applies lead in direction of target apparent motion.
5. Gunner lays crosshair leadline at center of target vulnerability.
6. Gunner makes final precise lay.
7. Gunner announces ON THE WAY.
8. Gunner fires main gun.
9. Gunner announces sensing and BOT.
10. Gunner relays (BOT).
11. Gunner announces ON THE WAY (BOT).
12. Gunner fires main gun (BOT).

The gunnery engagement and gunner behaviors come from two sources.

1. Boldovici, J.A. (HumRRO), Boycan, G.G. (ARI), Fingerman and Wheaton (AIR). M60A1AOS Tank Gunnery Data Handbook, ARI Technical Report TR-79-A7, March, 1979.

2. US Army, FM17-12, Tank Gunnery. March, 1977.

Figure 1. Gunnery Engagement

The controls and displays were derived for each behavioral element using the following basic guidelines: A control is something the operator acts on; a display is something that provides information to the operator so that he can act on a control. The analysis yielded six controls (e.g., main gun switch, Gunner's control handles) and seven displays (e.g., main gun switch light, reticle). The set of controls and displays is presented in Figure 2.

The knowledge and skills were derived for each behavioral element as follows: Knowledges and skills are the mental and motor components of the behavioral elements that have special requirements for minimum performance. Any knowledge or skill that could be learned or performed simply in response to verbal or written instructions was not identified as a knowledge or skill here. For example, "knows location of ammunition selector handle" is not a knowledge component for the behavioral element "Gunner indexes ammunition," since soldiers would remember the location after a single showing. Eleven knowledges (e.g., knows number of lead lines for ammunition types) and four skills (e.g., is able to estimate speed of target) were identified. They are listed in Figure 2. The controls, displays, knowledges, and skills associated with each behavioral element are given in Figure 3.

Prepare Workbooks

In preparing to apply the various models, procedures were extracted from reports describing TVI (Wheaton, et al., 1976), TVII (PM-TRADE, 1979), and TVIV (Swezey and Evans, 1980) for rating devices. Three workbooks were prepared from the extracted procedures. The intent of the workbooks was to enable raters to make judgments about a device in terms of the model component without being distracted by other material presented in the descriptive reports.

The TVIII (Narva, 1979) model is almost identical with TVIV regarding the variables or model components considered and in the procedures used to estimate these variables. For that reason, a workbook was prepared and ratings made for TVIV; these data were then used to calculate TRAINVICE scores for both TVIII and TVIV. The three models for which workbooks were

CONTROLS

C_1 Ammunition selector handle.
C_2 Main gun switch.
C_3 Microphone
C_4 Gunner's control handles.
C_5 Magnetic brake palm switches.
C_6 Firing triggers.

DISPLAYS

D_1 Earphones.
D_2 Ammunition display window.
D_3 Main gun switch light.
D_4 M-32 sight (eyepiece, headrest, 8X magnification).
D_5 Moving target.
D_6 Reticle.
D_7 Burst of main gun round.

KNOWLEDGES

K_1 Knows procedure to index ammunition (including when to index ammunition).
K_2 Knows that saying IDENTIFIED is response to TC saying GUNNER, (AMMO TYPE), (TARGET TYPE) and Gunner seeing the target.
K_3 Knows number of leadlines for ammunition types.
K_4 Knows number of leadlines for speed of target.
K_5 Knows crosshair leadline is placed on target's center of mass (with lead applied).
K_6 Knows that saying ON THE WAY is response to crosshair leadline being on target's center of mass, TC saying FIRE, and Loader saying UP.
K_7 Knows that sensing is mental notation of the point in the sight reticle where burst of round appears as it passes, strikes short of, or hits the target.
K_8 Knows there are three deflection sensings (LEFT, RIGHT, LINE) and four range sensings (SHORT, OVER, DOUBTFUL, TARGET).
K_9 Knows that saying BOT is response to sensing round.
K_{10} Knows to move point of sight reticle by most direct route from where burst of round appears to target's center of mass.
K_{11} Knows that saying ON THE WAY is response to point of sight reticle where burst of round appears being on target's center of mass and Loader saying UP.

SKILLS

S_1 Is able to distinguish between targets and friendlies.
S_2 Is able to estimate speed of target.
S_3 Is able to maintain smooth track.
S_4 Is able to sense rounds.

Figure 2. Controls (C), Displays (D), Knowledges (D), and Skills (S)

1. GUNNER INDEXES AMMUNITION
   - C_1 Ammunition selector handle.
   - D_1 Earphones (GUNNER, SABOT, MOVING TANK).
   - D_2 Ammunition display window.
   - K_1 Knows procedure to index ammunition (including when to index ammunition).

2. GUNNER TURNS ON MAIN GUN SWITCH
   - C_2 Main gun switch.
   - D_1 Earphones (GUNNER, SABOT, MOVING TANK).
   - D_3 Main gun switch light.

3. GUNNER ANNOUNCES IDENTIFIED
   - C_3 Microphone (IDENTIFIED).
   - D_1 Earphones (GUNNER, SABOT, MOVING TANK).
   - D_4 M-32 sight (eyepiece, headrest, 8X magnification).
   - D_5 Moving target.
   - K_2 Knows that saying IDENTIFIED is response to TC saying GUNNER, (AMMO TYPE), (TARGET TYPE) and Gunner seeing the target.
   - S_1 Is able to distinguish between targets and friendlies.

4. GUNNER APPLIES LEAD
   - C_4 Gunner's control handles.
   - C_5 Magnetic brake palm switches.
   - D_4 M-32 sight.
   - D_6 Reticle.
   - D_5 Moving target.
   - K_3 Knows number of leadlines for ammunition types.
   - K_4 Knows number of leadlines for speed of target.
   - S_2 Is able to estimate speed of target.
   - S_3 Is able to maintain smooth track.

5. GUNNER LAYS CROSSHAIR LEADLINE
   - C_4 Gunner's control handles.
   - C_5 Magnetic brake palm switches.
   - D_4 M-32 sight.
   - D_6 Reticle.
   - D_5 Moving target.
   - K_5 Knows crosshair leadline is placed on target's center of mass (with lead applied).
   - S_3 Is able to maintain smooth track

Figure 3. Controls (C), Displays (D), Knowledges (K), and Skills (S) for Behavioral Elements.

6. GUNNER MAKES FINAL PRECISE LAY
   - C_4 Gunner's control handles.
   - C_5 Magnetic brake palm switches.
   - D_4 M-32 sight.
   - D_6 Reticle.
   - D_5 Moving target.
   - K_5 Knows crosshair leadline is placed on target's center of mass (with lead applied).
   - S_3 Is able to maintain smooth track.

7. GUNNER ANNOUNCES ON THE WAY
   - C_3 Microphone (ON THE WAY).
   - C_4 Gunner's control handles.
   - C_5 Magnetic brake palm switches.
   - D_1 Earphones (UP, FIRE).
   - D_4 M-32 sight.
   - D_5 Moving target.
   - D_6 Reticle.
   - K_6 Knows that saying ON THE WAY is response to crosshair leadline being on target's center of mass, TC saying FIRE, and Loader saying UP.
   - S_3 Is able to maintain smooth track.

8. GUNNER FIRES MAIN GUN
   - C_4 Gunner's control handles.
   - C_5 Magnetic brake palm switches.
   - C_6 Firing triggers.
   - D_4 M-32 sight.
   - D_5 Moving target.
   - D_6 Reticle.
   - S_3 Is able to maintain smooth track.

9. GUNNER ANNOUNCES SENSING AND BOT
   - D_4 M-32 sight.
   - C_4 Gunner's control handles.
   - C_5 Magnetic brake palm switches.
   - C_3 Microphone (ON THE WAY).
   - D_6 Reticle.
   - D_5 Moving target.
   - D_7 Burst of main gun round.
   - K_7 Knows that sensing is mental notation of the point in the sight reticle where burst of round appears as it passes, strikes short of, or hits the target.
   - K_8 Knows there are three deflection sensings (LEFT, RIGHT, LINE) and four range sensings (SHORT, OVER, DOUBTFUL, TARGET).
   - K_9 Knows that saying BOT is response to sensing round.
   - S_4 Is able to sense rounds.

Figure 3. Controls (C), Displays (D), Knowledges (K), and Skills (S) for Behavioral Elements (Continued).

10. GUNNER RELAYS (BOT)
    - C_4 Gunner's control handles.
    - C_5 Magnetic brake palm switches.
    - D_4 M-32 sight.
    - D_5 Moving target.
    - D_6 Reticle.
    - D_7 Burst of main gun round.
    - K_{10} Knows to move point of sight reticle by most direct route from where burst of round appears to target's center of mass.
    - S_2 Is able to estimate speed of target.
    - S_3 Is able to maintain smooth track.

11. GUNNER ANNOUNCES ON THE WAY (BOT)
    - C_3 Microphone (ON THE WAY).
    - C_4 Gunner's control handles.
    - C_5 Magnetic brake palm switches.
    - D_1 Earphones (UP, FIRE).
    - D_4 M-32 sight.
    - D_5 Moving target.
    - D_6 Reticle.
    - K_1 Knows that saying ON THE WAY is response to point of sight reticle where burst of round appears being on target's center of mass and Loader saying UP.
    - S_3 Is able to maintain smooth track.

12. GUNNER FIRES MAIN GUN (BOT)
    - C_4 Gunner's control handles.
    - C_5 Magnetic brake palm switches.
    - C_6 Firing triggers.
    - D_4 M-32 sight.
    - D_5 Moving target.
    - D_6 Reticle.
    - S_3 Is able to maintain smooth track.

Figure 3. Controls (C), Displays (D), Knowledges (K), and Skills (S) for Behavioral Elements (Continued).

prepared involve several general types of preparatory analyses; these analyses are shown in Table 1. The reader is referred to Tufano and Evans (1982) for a thorough discussion of the preparatory analyses and model variables. A description of the preparation of the workbooks follows.

Prepare Workbook for TVI

The details for procedures and assumptions were increased and the rating procedures and instructions were geared to military raters. The workbook with subtasks, controls, displays, skills, and knowledges appropriately entered is presented in Appendix A. Following are the specific revisions or recommended revisions.

Physical similarity analysis (PSA). The PSA judges how well displays and controls are represented in the training device. The instruction to base the assessment on physical similarity and ignore amount and quality of information was moved from the definition of rating scale value 3 to the general instructions since it seemed to apply to all ratings. Also, the reference to "jnd" was deleted.

Functional similarity analysis (FSA). The FSA determines the information processes of the operator (type, amount, and direction of information) for each display and control and then compares the information requirements in the device to those in the operational equipment. The approach recommended for this analysis is considerably different from the Wheaton, et al. (1976) procedures. The revision was driven by the requirement for the rater to understand how to estimate the number of alternatives for a control or display. This seemed essential to enable later examination of the reliability of the analysis. The instructions were modified so that the rater determined the number of alternatives that the display or control under consideration could assume. This procedure was further modified by requiring the rater to determine whether the operator acts on the same amount of information for a control or display in the same way for both the operational and the training situation.

Table 1

Summary of Classes of Variables and Variables
Used By the Trainvice Models

Classes of Variable	I Analysis Name	I Variable Label	II Analysis Name	II Variable Label	IV Analysis Name	IV Variable Label
Task Coverage: Coverage Requirement	--	--	--	--	Coverage Requirement Analysis	
Task Coverage: Communality	Task Communality	C	Task Commonality	TC	Coverage Analysis	C
Prediction (Transfer): Physical/ Functional Similarity	Physical Similarity Analysis	P	Physical Similarity Index	PS	--	--
	Functional Similarity Analysis	F	Functional Similarity Index	FS	--	--
	Similarity Score	$S = \frac{(P)+(F)}{2}$				
Training Difficulty: Learning	Learning Deficit Analysis	D	Skills & Knowledge Requirements Index	SKR	Proficiency Analysis	P
			Task Training Difficulty Index	TTD	Learning Difficulty Analysis	D
Prediction (Transfer): Training Technique	Training Technique Analysis	T	--	--	Physical Characteristics Analysis	PC PC_{max}
					Functional Characteristics	FC FC_{max}

Learning deficit analysis (LDA). In TVI, the LDA determines the difference between the trainees' repertory of skills and knowledges and the level required to perform a subtask. In TVII, the LDA estimates how much the trainees have to learn, weighted by the time required to train them. TRAINVICE IV assesses the degree of proficiency required and the learning difficulty of each skill. The definitions for Repertory Scale appeared to refer too much to amount and type of training. The typical soldier described for the raters was a high school graduate in Armor OSUT who has completed the common soldier and tank driver blocks of instruction and was about to enter the gunnery phase of training. In this case, soldiers will not have received any training on any of the knowledges or skills, but they may have various levels of proficiency on the skills. For example, the typical soldier would probably be able to estimate one second "completely and accurately without supervision" (part of the definition for a score of 4). But he would not have received skill training on estimating (the remainder of that definition). Raters then could logically assign anything from a 0 to a 4 depending on whether they focus on level of proficiency or amount and type of training. The amount and type of training received was deleted from the definitions.

The Criterion Scale definitions seemed to be oriented toward describing the status of an imperfectly trained solider. Again, the focus needed to be on the requirements of the criterion task (hit moving target) rather than on the type of training received or the amount of further training required. For example, statements such as "needs more practice under supervision" may divert raters from the task requirements to the quality of an unspecified training program. The scale value defintions were revised to focus on knowledge or skill requirements of the criterion task.

Training techniques analysis (TTA). The purpose of the TTA is to establish how well a device implements established learning principles. This is done by using TECEP categories to determine task categories and rate how well the device implements the associated TECEP learning guidelines (from a "-3" which infers violation of a principle to a "3" which infers optimal implementation). The rater identifies the lowest rating of each task

category and then averages and scales these scores to yield a "T" score between "0" and "1".

The procedures associated with this analysis were not clear in specifying when the rater should rate the principles for each task category. That is, should the rater rate every category or should the rater first determine which principles are relevant to the subtasks being rated. Determining the relevant principles before rating appeared to be more reasonable in that a principle may be more relevant to some subtasks but not others. For instance, the mnemonic to apply to adjusting lead to compensate for motion in the firing tank is not apparent. But the lack of apparent relevance does not affect the comparative effectiveness of a device. This can be a problem because the model only incorporates the lowest rating in a cell. An irrelevant principle would wash out any positive applications of learning principles.

Despite this theoretical drawback, the instructions call for rating each principle in each cell. The main reason for that instruction is the definition of zero in the scale. One reason for a zero is that the principle is irrelevant. That implies that there is no screening for relevance. A more basic problem relates to the purpose of the analysis. Research Memorandum 76-16 (Wheaton, et al.) states that the purpose is to tell the incremented training value that a specific device possesses over operational equipment (p. 39). However, the procedure makes no reference to operational equipment. The Memorandum later recommends an approach which assigns the zero point to the operational equipment and rates each device in terms of gain or decrease compared with that equipment (p. 43). Such a modification would also resolve the relevance problem. This approach, if adopted, would probably require use of the average score rather than the lowest score.

Two recommendations are presented for revisions to the training techniques analysis procedure. They are:

1. Rework the scale to compare devices' application of principles with operational equipment's application of principles; or,

2. Continue with current procedures but have raters screen principles in each relevant cell to identify the principles that apply to the subtask. Eliminate "inapplicable or irrelevant" from the definition for zero.

Prepare Workbook for TVII

The main confusion with TVII instructions related to unique elements and controls. A device is supposed to be penalized for task elements and controls that are "unique to the device but not needed." The materials (PM-TRADE, 1979) give no examples. Since the analysis proceeds by task, the most likely interpretation is to penalize features that are unrelated to the task being considered. By a strict interpretation, the ability to show motion, for example, would be unique for the task "engage stationary targets." But the scope of a task is often arbitrary. In this case the task could just as easily be "fire main gun" in which case the ability to show motion would not be a unique element. The instructions therefore call for considering an element unique if it is unrelated to entry-level gunnery. The rating sheets were modified so that raters would list what they considered to be unique elements. The TVII Workbook is in Appendix B.

Prepare Workbook for TVIV

The problems with TVIV related to the definitions for Training Proficiency and Learning Difficulty. The confusion stemmed from the definitions for the scale values. Training Proficiency is supposed to describe the ability of the soldier that the system requires. But the definitions refer primarily to the amount or quality of training received. When the system requirements are mentioned, the context is illogical: A rater gives a 1 when the system would require only a limited knowledge and would be seriously degraded by limited knowledge. Raters with a criterion referenced attitude would have trouble telling the difference between a minimally competent and an adequate skill, particularly when system requirements are being asked

for. Similarly, the definition of expert-level skill is also not consonant with the purpose. The following scale value definitions are recommended:

Rating	Definition
1	Should have skill or knowledge equivalent to briefing on knowledge or one performance of skill. System will tolerate frequent errors.
2	Should have skill or knowledge equivalent to briefing and some practice, but does not need to be able to apply knowledge or skill without error. System will tolerate occasional errors.
3	Should be able to apply skill or knowledge under most conditions without hesitation. System will tolerate infrequent errors.
4	Should be able to apply skill or knowledge under all conditions without hesitation. System will not tolerate errors.

The Learning Difficulty definitions may depend too much on maintaining rather than acquiring proficiency. Also it is not clear whether "instruction" in 2, 3, and 4 is intended to be limited to description or includes hands-on practice. Appendix C is the TVIV Workbook.

Perform Ratings

The ratings were made by two independent raters. The first rater applied each TRAINVICE model to all four devices; the second rater applied TRAINVICE II, III, and IV to all four devices and TVI to the VIGS only. The rating design is shown in Figure 4. Each rater familiarized himself with the VIGS device by practicing a prescribed sequence of engagements until each felt confident enough to do the ratings. The two raters were familiar with the remaining three devices through other projects and refreshed their memories by reviewing the particular descriptions in DA Pam 310-12 (1976).

Device Model	VIGS	BOT	M55	BRW
TV-I	Rater 1 Rater 2	Rater 1 --	Rater 1 --	Rater 1 --
TV-II	Rater 1 Rater 2	Rater 1 Rater 2	Rater 1 Rater 2	Rater 1 Rater 2
TV-III	Rater 1 Rater 2	Rater 1 Rater 2	Rater 1 Rater 2	Rater 1 Rater 2
TV-IV	Rater 1 Rater 2	Rater 1 Rater 2	Rater 1 Rater 2	Rater 1 Rater 2

Figure 4. Rating design for TRAINVICE Workbooks

RESULTS-PREDICTORS

The overall TRAINVICE scores computed for raters 1 and 2 are in Table 2. The scores that each model assigns vary greatly. This generates questions concerning what relationship a value for a particular model has when compared to a second model on the same training device. For example, rater 1 applying TVI awards the VIGS device .34, but the same rater using TVII awards the VIGS .90. Of particular concern is the difference between TVIII and TVIV. The scores assigned by each of the models are quite different from one another (e.g., where the two raters using TVIII assign a .38 and .41 for the VIGS device, the TVIV scores are .67 and .74). However, the data recorded in the workbooks for these two devices are identical. The only difference between the two models is in the equation each one uses. Furthermore, the TVIV scores for the last two devices (M55 and BRW) differ greatly between the raters whereas for TVIII both raters' scores are almost identical. Again, since the only difference between the two models is the equation each uses, these results raise some interesting questions about the equations each of the four models uses to produce a "prediction value." The issue of the relationships of values from one model compared to another model is presented in the Discussion section.

Although the actual scores which each TRAINVICE model assigns are different, the rank order of these scores produces a fairly consistent pattern. Figure 5 illustrates this by displaying each of the TRAINVICE scores in relation to one another for each rater. Figure 6 compares the pattern of the TRAINVICE scores for each rater (with the exception of TVI in which only rater 1 completed the analysis). In general, the patterns of the scores are similar between the raters. In fact, the actual TRAINVICE scores (presented in Table 2) are not considerably different between raters (with the exception of TVIV on the M55 and BRW devices).

There was a high degree of agreement among the predictions generated by the four TRAINVICE models, for each of the raters. The statistic used to reflect this multiple correlation was Kendall's Coefficient of Concordance (W)

Table 2

TRAINVICE SCORES

MODEL	DEVICE							
	VIGS		BOT		M55		BRW	
	Rater 1	Rater 2	Rater 1	Rater 2	Rater 1	Rater 2	Rater 1	Rater 2
TVI	.34	.35	.21	a	.51	a	.51	a
TVII	.90	.81	.82	.69	.98	.98	.98	.98
TVIII	.38	.41	.32	.38	.54	.53	.54	.54
TVIV	.67	.74	.58	.43	1.00	.59	1.00	.59

[a]Rater 2 did not complete ratings for this device.

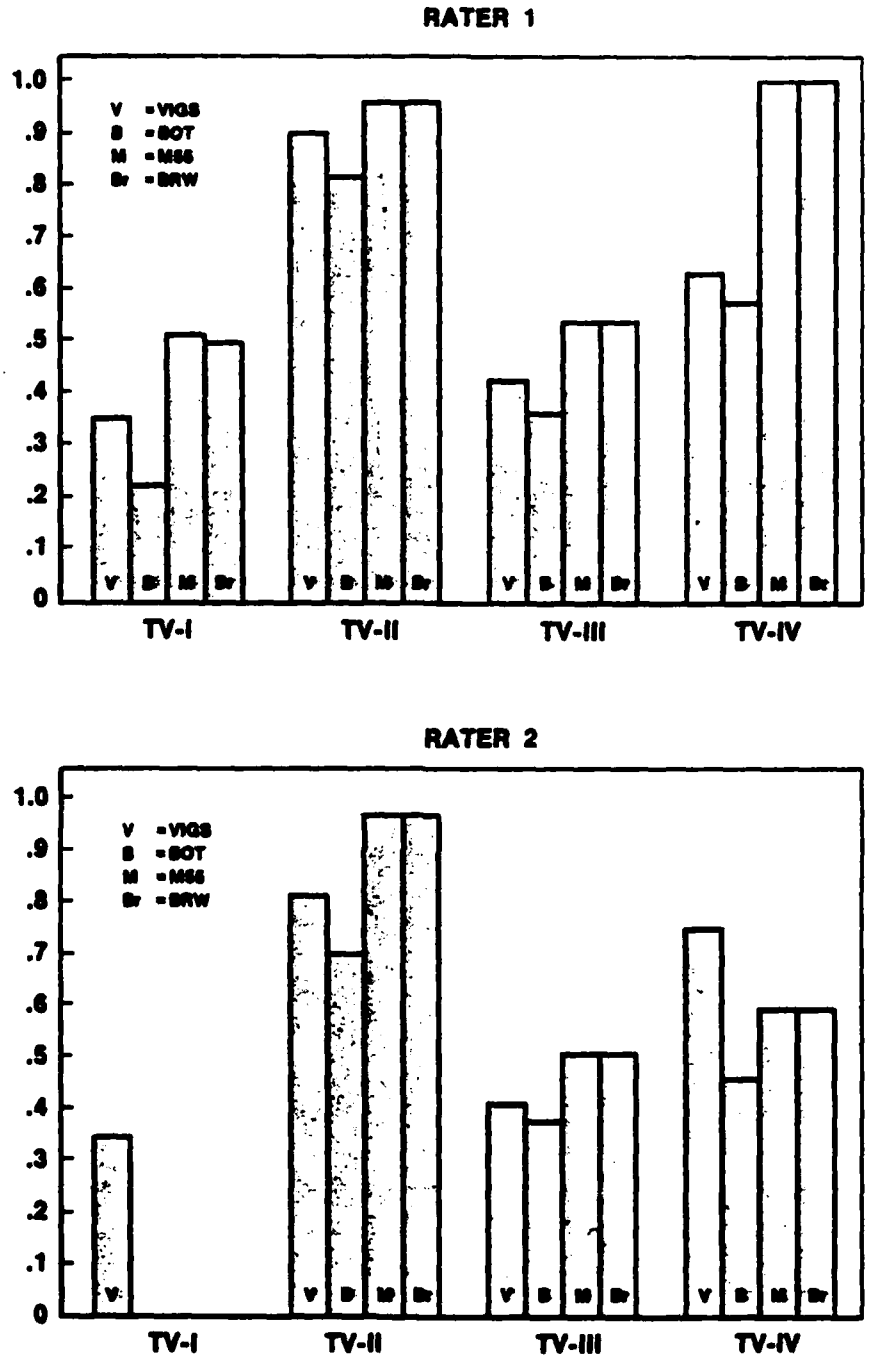

Figure 5. **TRAINVICE Scores in Relation to Each Other (By Rater By Device)**

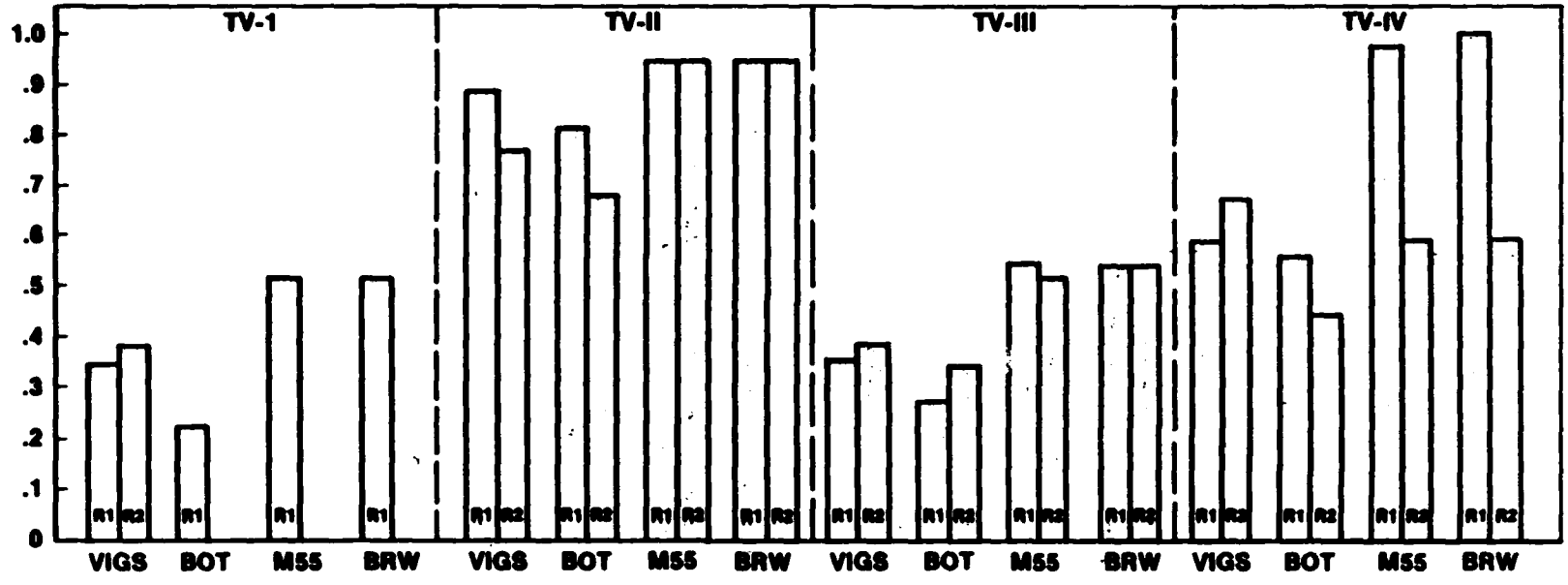

Figure 6. **Comparison of TRAINVICE Score Patterns by Raters**

(Siegel, 1956) which took into account the rank ordering of each model's predictions across the four training devices in question. For rater 1, $W = .85$ ($p < .01$). Since rater 2 had only applied TVII, TVIII, and TVIV to all four devices, his coefficient of concordance (.63) was less reliable; $p < .15$. The immediate implication of these results is that perhaps the simplest prediction method (TVII) is the one to use since its predictions agree with the more complicated methods.

Since inter-rater agreement was high for the TRAINVICE indices, we wanted to see if the raters agreed consistently throughout the rating procedure. There are two reasons for this: (1) If the raters are not agreeing, then an analysis of rater-agreement will pinpoint areas in the model that need to be more specific in defining their rating criteria; and (2) If the raters are not agreeing, then one must question whether the TRAINVICE model is producing an accurate measure.

To indicate the extent to which raters produced similar ratings, a simple "percent-agreement" score was computed for each of the component variables of each TRAINVICE model. These are displayed in Table 3. Tufano and Evans (1982) designed the framework of this table to show the commonalities among the four models in terms of their various analyses. In observing the rater agreement within these variables, particular areas have produced consistent degrees of rater agreement across all of the TRAINVICE models. Specifically, in the coverage of commonality analysis, rater agreements are generally 80-100%. In the learning and training technique analysis, rater agreements are generally below 50%.

Table 3

PERCENTAGE OF RATER AGREEMENT

CLASS OF VARIABLE	TVI RATER AGREEMENT(%)				TVII RATER AGREEMENT(%)				TVIII* RATER AGREEMENT(%)				TVIV RATER AGREEMENT(%)			
	ANALYSIS NAME	VIGS	BOT	M55	BRW	ANALYSIS NAME	VIGS	BOT	M55	BRW	ANALYSIS NAME	VIGS	BOT	M55	BRW	ANALYSIS NAME	VIGS	BOT	M55	BRW
COVERAGE REQUIREMENT	---					---					Coverage Requirement Analysis (CR)	100	100	100	100	Coverage Requirement Analysis (CR)	100	100	100	100
COMMUNALITY	Task Communality (C)	100	94	100	100	Task Communality (TC)	100	75	100	100	Coverage Analysis (C)	93	80	80	80	Coverage Analysis (C)	93	80	80	80
PHYSICAL/ FUNCTIONAL SIMILARITY	Physical Similarity Analysis (P)	77	64	95	95	Physical Similarity Index (PS)	46 (92)	69 (92)	100	92 (100)	---					---				
	Functional Similarity Analysis (F)	77	70	96.3	96.8	Functional Similarity Index (FS)	77 (85)	85 (92)	100	100										
LEARNING	Learning Deficit Analysis (D)	*25	25	25	25	Skills & Knowledge Requirements Index (SKR)	47 (87)	47 (87)	47 (87)	47 (87)	Training Criticality Analysis (C_1)	47	47	47	47	Proficiency Analysis (P)	47	47	47	47
	(Includes Proficiency Difficulty Analyses)	** 83	83	83	83	Task Training Difficulty Index (TTD)	33 (75)	33 (75)	33 (75)	33 (75)	Training Difficulty Analysis (D)	27	27	27	27	Learning Difficulty Analysis (D)	27	27	27	27
		*** 50	50	50	50															
TRAINING TECHNIQUE	Training Techniques Analysis (T)	**** 32.7	0	0	0	---					Physical Characteristics Analysis (PC and PC_{max})	*13	13	13	13	Physical Characteristics Analysis (PC and PC_{max})	*13	13	13	13
											Functional Characteristics (FC and FC_{max})	13	13	13	13	Functional Characteristics Analysis (FC and FC_{max})	13	13	13	13

*Based on scores within .10 of each other.
**Based on ratings within 1 point of each other.
***Based on ranks within 2 ranks of each other.
****Based on number of behavioral categories in common.

*( ) = all numbers in parentheses indicate agreement of raters is only one scale value apart.

☆2 out of 15 skills placed in same behavioral category.

☆Recall that rater agreement for TVIII was completed from the TVIV ratings. The difference in the models lies in the computation of the TRAINVICE scores.

*2 out of 15 skills placed in same behavioral category.

METHOD-DATA COLLECTION

Plan

The data collection plan was to give a set of Armor OSUT soldiers specific opportunities to practice gunnery tasks on the VIGS rather than the normal OSUT gunnery training. Their subsequent dry fire performance with the M55 laser on two engagements each from Tank Tables II (night) and III (night) would be compared with the performance of another set of Armor OSUT soldiers who had normal OSUT gunnery training and no practice on the VIGS. Performance of each group would also be compared with performance predicted by TRAINVICE ratings. The VIGS training was presented at two levels of intensity, a high and low level.

Subjects

Twenty-nine soldiers from one OSUT company and 28 from another participated. They were represented in three groups, as follows:

Company	Normal OSUT Gunnery	Low VIGS	High VIGS
B41	10	10	9
D21	9	10	9

Training Method

Subjects in the high and low level training groups were given training as described in Hoffman and Melching (1982). Essentially, the two levels of VIGS training were substituted for a portion of regular OSUT training on the M55 laser. The high group was administered two VIGS training modules; the low group, was administered one module.

Module 1 training on the MK60 for both high and low level groups occurred during week ten of training. It was substituted for approximately eight hours of the time normally devoted to training on Tank Tables I, II, and III (Day Fire) using the M55 laser mounted on turret trainers. Subjects who were assigned to high level training returned two weeks later for Module 2 training. The training module was scheduled for five hours and occurred

immediately after subjects had received their .22 caliber Brewster device exercises. All groups had training on the burst-on-target (BOT) trainer.

A list of the engagements on the VIGS is shown in Table 4. A sample training module used by Hoffman and Melching (1982) is presented as Figure 7.

Testing Method

All subjects fired Tank Tables II (night) and III (night). The description of Tank Table II (night) is as follows:

> Task: Employ BOT method of adjustment (Engagements 1 and 4)
>
> Conditions: Using a sub-caliber (laser) device, the Gunner will adjust fire from a first round miss, using BOT method of adjustment. Gunner fire at stationary targets from a stationary tank under white light or IR.
>
> Standards: Gunner must hit target with second round and use correct adjustment techniques to qualify on Table II (night).
>
> Equipment Set-up: An elevation error is induced into the computer to cause a first round miss requiring fire adjustment.

The description of Tank Table III (night) is as follows:

> Task: Employ BOT method of adjustment (Engagements 1 and 3).
>
> Conditions: Using a sub-caliber (laser) device, the Gunner will adjust fire from a first round miss, using BOT method of adjustment. Gunner will fire at moving targets from a stationary tank under white light or IR.
>
> Standards: Gunner must hit targets with second round and use correct adjustment techniques to qualify on Table III (night).
>
> Equipment Set-up: An elevation error is induced into the computer to cause a first round miss requiring fire adjustment.

TABLE 4

TARGET CHARACTERISTICS AND AMMUNITION IN THE 20 VIGS ENGAGEMENTS

Target Type	Target Range	Target Movement	Target Cover	Ammo
Tank	456	Closing	No	HEAT
Tank	500	Closing	No	HEAT
Tank	1000	Closing	No	HEAT
Tank	1030	Closing	No	APDS
APC	800	Closing	No	HEP
Tank	500	Crossing	No	HEAT
Tank	1000	Crossing	No	APDS
Tank	406	Closing	Yes	APDS
Tank	588	Closing	Yes	APDS
2 Tanks	456	Closing	No	HEAT
APCk	1326	Crossing	No	HEAT
2 Tanks	1400	Closing	No	APDS
APCk	1130	Crossing	No	HEP
Tank	1200	Crossing	No	HEAT
Tank	1130	Closing	Yes	HEAT
Tank	500	Crossing	Yes	APDS
Tank	1430	Crossing	No	APDS
2 Tanks	1230	Crossing	No	HEAT
Tank	1300	Crossing	Yes	HEAT
2 Tanks	1230	Crossing	No	HEAT

BAT
Module 1
MK60 VIDEODISC SIMULATOR
GUNNERY TRAINING

Partial Substitute for Lesson Plan GC050

MK60 Training in Lieu of TANK TABLES I, II, and III (Day)

A. Administrative Instructions:

1. When training will be given: During time Tank Tables I, II, and III (Day) training is normally given.

2. Training location: SK Hall

3. Who will be trained: Sixteen (16) men, 8 from 2 platoons. List of selected personnel will be provided by ARI R&D Coordinator.

4. Instructors: Four (4) Assistant Instructors/Tank Commanders (AI/TC), one for each MK60 device.

5. Training Aids:

   (a) Four MK60 simulators, regular and BOT floppy discs, and videodisc.
   (b) Practice Monitor Forms.

6. References:

   (a) FM 17-12 w/changes 1 and 2
   (b) FM 17-12-2 w/changes 1 and 2
   (c) Lesson Plan GC050
   (d) MK60 Gunnery Trainer Operator's Manual
   (e) Training Objectives and Videodisc Specifications for use with the Perceptronics Videodisc Gunnery Simulator, ARI/HumRRO, January 1982.

B. Training Objectives:

TASK: Perform the steps required of the M60A1 tank gunner using the MK60 simulator.

CONDITIONS: Given a functioning MK60 simulator, standard and BOT floppy discs, MK60 kill zone set at 100%, and the twenty-problem videodisc.

STANDARDS: Achieve the level of performance stated below for each intermediate objective.

Figure 7. Sample Training Module

Each soldier was permitted two rounds for each engagement. As noted, the lesson plan requires the Tank Commander to induce an elevation error into the computer. The purpose of inducing the error is to cause a first-round miss so the soldier will be required to apply the BOT method of adjustment for the second round.

Tank Commanders scored for each engagement YES or NO for the following behavioral elements corresponding to the task "hit moving target":

1. Correct ammunition indexed.
2. Main gun switch on.
3. Announces identified.
4. Correct lead (only for the two Table III moving target engagements).
5. Announces on the way.
6. Hits.
7. Senses - BOT.
8. Re-lays.
9. Announces on the way.
10. Hits.

Figure 8 is a sample score sheet.

NAME _____

PLATOON _____

SSN _____

TABLE II

ENGAGEMENT	CORRECT AMMUNITION INDEXED	MAIN GUN SWITCH ON	ANNOUNCES IDENTIFIED	ANNOUNCES ON THE WAY	HITS	SENSES BOT	RE-LAYS	ANNOUNCES ON THE WAY	HITS	TIME (SECS)
1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	_____
4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	_____

TABLE III

ENGAGEMENT	CORRECT AMMUNITION INDEXED	MAIN GUN SWITCH ON	ANNOUNCES IDENTIFIED	CORRECT LEAD	ANNOUNCES ON THE WAY	HITS	SENSES BOT	RE-LAYS	ANNOUNCES ON THE WAY	HITS	TIME (SECS)
1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	_____
3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	_____

Figure 8. Score Sheet for Tables II and III (Night)

RESULTS-DATA COLLECTION

Table 5 is the raw data for all behavioral elements for each Company (B41 and D21). "Lead" scores were not collected on tank gunnery Table II since stationary tank-stationary target engagements require no lead. The raw data for selected behavioral elements were combined by companies (but kept separate by gunnery Table) and converted to percents (Table 6). The percent YES for these behavioral elements is shown on the graph at Figure 9. Other behavioral elements were not examined as they appear on inspection of the raw data to be successfully performed by all three groups. The elements examined and not examined are:

Examined	Not Examined
Leads	Index ammo
Hits	Main gun on
Senses-BOT	Say "Identified"
Re-lays	Say "On the Way"
Hits	Say "On the Way"

The TRAINVICE scores computed earlier for rater 1 are below. Since TVI ratings were incomplete for rater 2, his ratings were not used in the comparison. One would expect the normal OSUT gunnery group, with the benefit of M55 laser day firing, to do better on the M55 laser night firing than either the low VIGS or high VIGS which did not have M55 laser day firing. That, at least, is what the TRAINVICE scores predict. That did not happen across the board (see Figure 9). Only on "Leads," did the normal OSUT training group perform more successfully than the High- and Low-VIGS groups.

	VIGS	BOT	M55	BRW
TVI	.34	.21	.51	.51
TVIII	.90	.82	.98	.98
TVIV	.67	.58	1.00	1.00

	ENGAGEMENT	GROUP	INDEX AMMO [a]			MAIN GUN ON			SAY "IDENTIFIED"			LEAD			SAY "ON THE WAY"			HIT			SENSE BOT			RE-LAY			SAY "ON THE WAY"			HIT		
			1	2[b]	3[c]	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
TABLE II		CONT	10	0	0	8	2	0	10	0	0				10	0	0	5	5	0	9	1	0	9	1	0	9	1	0	9	1	0
	1	LOW	8	2	0	10	0	0	10	0	0				10	0	0	4	6	0	9	1	0	10	0	0	10	0	0	8	2	0
		HIGH	7	2	0	8	1	0	9	0	0				9	0	0	4	5	0	7	2	0	9	0	0	9	0	0	8	1	0
		CONT	10	0	0	8	2	0	9	0	1				10	0	0	4	6	0	10	0	0	10	0	0	10	0	0	7	3	0
	4	LOW	9	1	0	10	0	0	10	0	0				8	2	0	4	6	0	10	0	0	10	0	0	9	1	0	9	1	0
		HIGH	9	0	0	8	1	0	8	0	1				8	1	0	3	6	0	8	1	0	8	1	0	8	1	0	7	2	0
TABLE III		CONT	9	0	0	8	1	0	8	1	0	8	1	0	9	0	0	2	7	0	8	1	0	9	0	0	9	0	0	8	1	0
	1	LOW	9	0	0	9	0	0	9	0	0	7	2	0	9	0	0	3	5	1	9	0	0	9	0	0	9	0	0	7	2	0
		HIGH										(NO MOVING TARGET)																			
		CONT	9	0	0	8	1	0	9	0	0	8	1	0	9	0	0	3	6	0	9	0	0	9	0	0	9	0	0	8	1	0
	3	LOW	9	0	0	9	0	0	9	0	0	8	1	0	9	0	0	4	5	0	9	0	0	9	0	0	9	0	0	8	1	0
		HIGH										(NO MOVING TARGET)																			

B-4-

TABLE II		CONT	8	1	0	8	1	0	9	0	0				8	1	0	6	3	0	7	2	0	6	2	1	8	1	0	7	2	0
	1	LOW	10	0	0	10	0	0	8	2	0				9	1	0	9	1	0	10	0	0	5	0	5	7	0	3	9	0	1
		HIGH	8	1	0	8	1	0	7	2	0				7	2	0	5	3	1	6	3	0	6	2	1	7	2	0	6	3	0
		CONT	8	1	0	7	2	0	6	1	2				9	0	0	8	1	0	8	1	0	6	2	1	8	1	0	8	1	0
	4	LOW	10	0	0	10	0	0	10	0	0				10	0	0	9	1	0	10	0	0	8	0	2	10	0	0	8	2	0
		HIGH	8	1	0	9	0	0	7	2	0				8	1	0	4	5	0	7	2	0	7	1	1	8	1	0	7	2	0
TABLE III		CONT	9	0	0	8	1	0	8	1	0	7	2	0	8	1	0	5	4	0	7	2	0	7	0	2	7	1	1	7	1	1
	1	LOW	10	0	0	10	0	0	10	0	0	7	2	1	10	0	0	7	3	0	10	0	0	8	0	2	10	0	0	9	0	1
		HIGH	7	2	0	9	0	0	7	2	0	5	3	1	8	1	0	6	3	0	5	3	1	7	1	1	7	2	0	8	1	0
		CONT	6	2	1	8	0	1	8	0	1	7	1	1	8	0	1	7	2	0	7	1	1	7	0	2	7	1	1	8	1	0
	3	LOW	10	0	0	10	0	0	10	0	0	8	2	0	10	0	0	6	4	0	10	0	0	8	0	2	9	1	0	9	1	0
		HIGH	7	2	0	9	0	0	7	2	0	8	1	0	9	0	0	5	3	1	8	1	0	6	2	1	8	1	0	8	1	0

D-2-

[a] 1 = YES
[b] 2 = NO
[c] 3 = Not Scored

Table 5
Raw data for all behavioral elements

TABLE II

	HITS YES	HITS NO	HITS N.S.[a]	SENSES BOT YES	SENSES BOT NO	SENSES BOT N.S.	RE-LAYS YES	RE-LAYS NO	RE-LAYS N.S.	HITS YES	HITS NO	HITS N.S.
CONT	23/38	15/38	0	34/38	4/38	0	31/38	5/38	2/38	31/38	7/38	0
LOW	26/40	14/40	0	39/40	1/40	0	33/40	0	7/40	34/40	5/40	1/40
HIGH	16/36	19/36	1/36	28/36	8/36	0	30/36	4/36	2/36	28/36	8/36	0
CONT	61	39	0	89	11	0	82	13	5	82	18	0
LOW	65	35	0	98	2	0	83	0	17	85	13	2
HIGH	44	53	3	78	22	0	83	11	6	78	22	0

Raw scores

Percent

TABLE III

	LEADS YES	LEADS NO	LEADS N.S.	HITS YES	HITS NO	HITS N.S.	SENSES BOT YES	SENSES BOT NO	SENSES BOT N.S.	RE-LAYS YES	RE-LAYS NO	RE-LAYS N.S.	HITS YES	HITS NO	HITS N.S.
CONT	30/36	5/36	1/36	17/36	19/36	0	31/36	4/36	1/36	32/36	0	4/36	31/36	4/36	1/36
LOW	30/38	7/38	1/38	20/38	17/38	1/38	38/38	0	0	34/38	0	4/38	32/38	6/38	0
HIGH	13/18	4/18	1/18	11/18	6/18	1/18	13/18	4/18	1/18	13/18	3/18	2/18	16/18	2/18	0
CONT	83	14	3	47	53	0	86	11	3	89	0	11	86	11	3
LOW	79	18	3	52	45	3	100	0	0	89	0	11	84	16	0
HIGH	72	22	6	61	33	6	72	22	6	72	17	11	89	11	0

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Table 6

Raw data for selected behavioral elements, both companies (D21, B41) combined

[a] N.S. = Not Scored

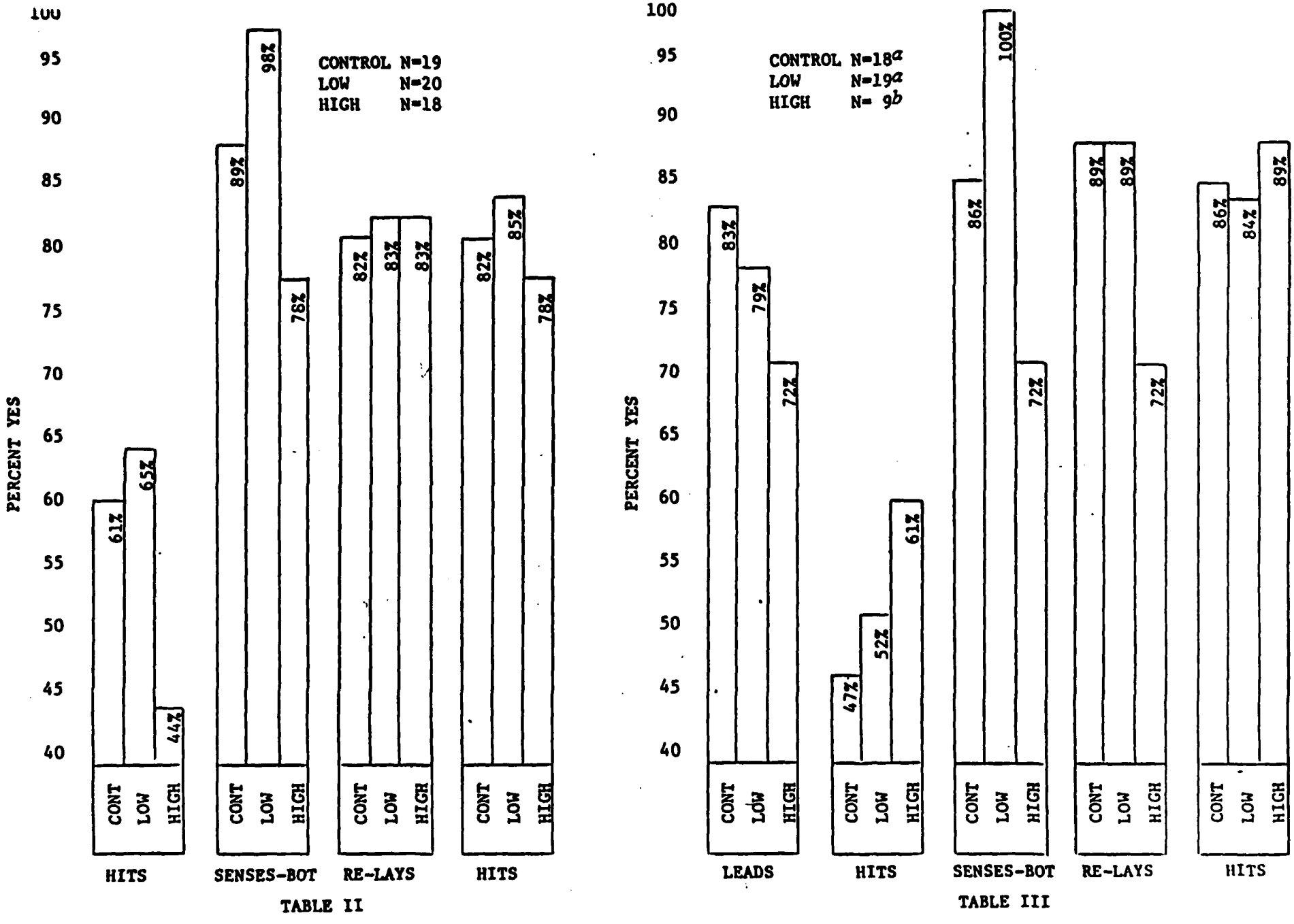

Figure 9. Percent YES for selected behavioral elements, both companies (D21, B41) combined

In all other cases, except Re-Lays (Tank Gunner Table II) and Hits (first round, Tank Gunnery Table III), the normal OSUT training group did better than only one of the VIGS groups (usually the High group). On Re-Lays (Tank Gunnery Table II) and Hits (first tround, Tank Gunnery Table III), both the high and low-VIGS groups did better than the normal OSUT training group.

The low-VIGS group tended to perform better than the high-VIGS group. An exception to this is that the high group did better than the low group on both first and second round hits on Tank Gunnery Table III.

DISCUSSION

With the exception of TVIV scores on M55 and BRW the TRAINVICE scores were not considerably different between raters 1 and 2 (see Table 2). Since two independent raters produced similar results, one could assume that the TRAINVICE indices are reliable measures. However, in observing the component variables of each TRAINVICE model it was found that inter-rater agreement was actually low for particular classes of variables within each of the models; specifically, the learning and training technique variables (see Table 3). These classes of variables require the rater to use more subjective judgment than the coverage requirement, commonality, and physical/functional similarity variables (which all produced high inter-rater reliability). Thus, increased subjectivity required by the analysis results in decreased reliability of the ratings.

Empirical data were collected in order to relate the predictor estimates to the criterion measures (transfer data). The challenge in relating the predicted transfer of the criterion measures lies in the nature of the transfer index. TRAINVICE (in its various forms) produces an index that ranges between 0 and 1; higher index values within a model predict higher transfer. The values "look like" percentages and if they were one could hypothesize that criterion scores would produce significant differences in the same direction as the transfer values. Unfortunately, the transfer scores are not percentages of any other measure for which the distribution is known. Thus, one would be hard-pressed to design a statistical test for transfer indexes.

What one gets from the repeated applications by a number of users to a number of training devices is the start of data that ultimately will show the distribution of the index. Then, one can rank order the indices and the criterion results and apply distribution-free tests such as rank correlation coefficients. Then, one can determine whether apparent differences in transfer index values are associated with practical differences (in the same direction) in the criterion scores.

The results of the data collection indicate the difficulties inherent in collecting criterion data when one does not have nearly absolute control of the data collection. Personnel in charge of inducing elevation error into the computer routinely failed to do so. The data, uniformly for each behavioral element, are without variance. One is hard-pressed to imagine OSUT gunners who would perform as well if conditions were better controlled and scorers were more objective.

Recommendations

Problems remain. Some are practical and reasonably easy to solve. For example, consider the problem of increasing the reliability of the predictor measurement. Boldovici, Osborn, and Harris (1977) assert that one can increase measurement reliability by manipulating systematic variations introduced in the variables. In this case, variations are apparently present in the kinds of instructions given to the raters, i.e., the specificity of the instructions and, perhaps, the amount of practice given to the raters for using the procedure.

By increasing the specificity of the instructions, one can increase the measurement reliability. Furthermore, by giving the rater a well defined standard stimulus for rating and requiring the rater to make a comparative rather than an absolute judgment, performance will be more reliable.

Criterion measurement is another problem which is reasonably easy to solve. Criterion data can be improved if collected in laboratories using simple devices rather than in field settings using complex weapon systems.

Other problems are more conceptual at this point and require more thought. As an example, consider the issue of intuitive versus counterintuitive predictions.[1] Figure 10 shows possible outcomes of

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[1]The authors wish to thank Dr. John A. Boldovici for the conceptual framework described here.

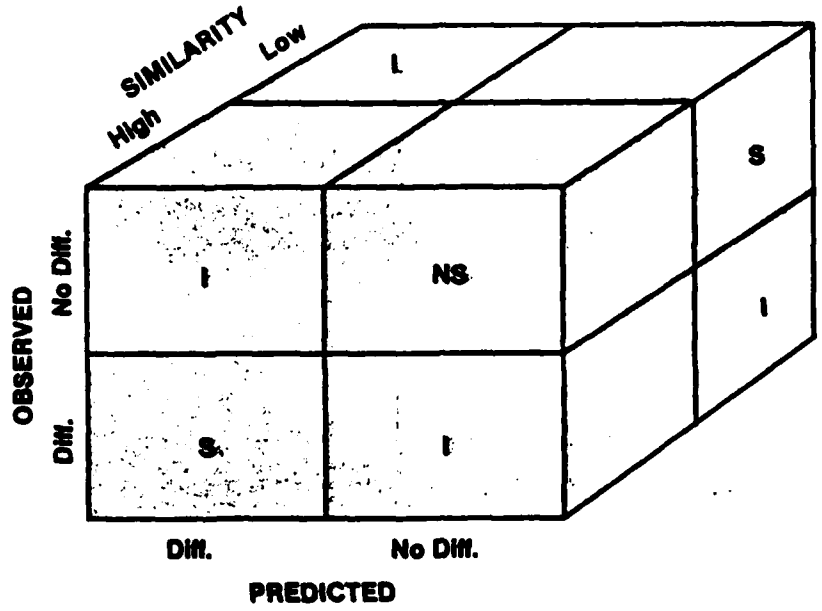

Figure 10. **Possible Outcomes of Transfer Forecasting as Functions of Similarity Between Compared Devices, and Compared Devices, and Whether Predictions Match Observations (I=Improvement Required in Model or Measurement, NS=No Surprise, S=Surprise).**

transfer forecasting of similarity between compared devices, and whether predictions match observations.

The four cases in which predictions and observations do not match (I in the figure) are not particularly instructive. They show something is wrong with the model or the measurement, but not which one. The no surprise (NS) cases, one (low/dif/dif) of which is hidden in the figure, are those in which (a) a difference in transfer is both predicted and observed for dissimilar devices, and (b) no difference in transfer is both predicted and observed for similar devices. One could argue that models are not needed to predict those kinds of results (i.e., no surprise). The two S (surprise) cases are the interesting ones, in which (a) a difference in transfer is both predicted and observed for similar devices, and (b) no difference in transfer is both predicted and observed for dissimilar devices. How do we get models capable of predicting those kinds of outcomes? One way is to find literature in which (a) similar devices (or treatments) produced dissimilar transfer, and (b) dissimilar devices (or treatments) produced similar transfer (research on procedures learning, for example). Then ask, "What characteristics would a model have to have to produce those results?"

REFERENCES

Boldovici, H.A., Boycan, G.G., Fingerman, P.W., & Wheaton, G.R. (1979). Tank Gunnery Data Handbook (ARI Technical Report TR-79-A7). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Boldovici, J.A., Osborn, W.C., & Harris, J.H. (1977). Reliability in Measuring Unit Performance. In W.C. Osborn, J.P. Ford, C.H. Campbell, R.C. Campbell, J.H. Harris, & J.A. Boldovici Military Testing: Knowledge and Skills; Criticality and Reliability (HumRRO PP-4-78). Alexandria, VA: Human Resources Research Organization.

Braby, R., Henry, J.M., Parris, W.F., Jr., & Swope, W.M. (1975). A Technique for Choosing Cost-Effective Instructional Delivery Systems (TAEG Report No. 16). Orlando, FL: Department of Navy, Training Analysis and Evaluation Group.

Hoffman, R.G., & Melching, W.G. (1982). Field Trials of the MK60 Gunnery Simulator in Armor Institutional Training Courses. Volume I: Final Report. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Narva, M.A. (1979). Development of a Systematic Methodology for the Application of Judgmental Data to the Assessment of Training Device Concepts. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

PM-TRADE (1979). Training Device Requirements Documents Guide. Orlando, FL: Naval Training Equipment Center.

Seigel, S. (1956). Nonparametric Statistics for the Behavioral Sciences. New York: McGraw Hill.

Swezey, R.W., & Evans, R.A. (1980). Guidebook for Users of TRAINVICE III. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Tufano, D.R., & Evans, R.A. (1982). The Prediction of Training Device Effectiveness: A Review of Army Models (ARI PB 3114). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

U.S. Army (1976). Hq Department of the Army, Index and Description of Army Training Devices (DA Pam 310-12). Washington, DC: Author.

Wheaton, G.R., Fingerman, P.W., Rose, A.M., & Leonard, R.L., Jr. (1976). Evaluation of the Effectiveness of Training Devices: Elaboration and Application of the Predictive Model (ARI Research Memorandum 76-16). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Wheaton, G.R., Rose, A.M., Fingerman, P.W., Korotkin, A.L., & Holding, D.H. (1976). Evaluation of the Effectiveness of Training Devices: Literature Review and Preliminary Model. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

APPENDIX A

TVI WORKBOOK

Task Communality Analysis

The purpose of the task communality analysis is to describe the overlap in training content between the operational situation and the training device. Communality is said to exist when a subtask can be performed and practiced in the training situation (device) and in the operational situation.

Rate each subtask on the following two-point scale:

Rating	Definition
1	Training device permits practice of the subtask.
0	Training device does not permit practice of the subtask.

TASK COMMUNALITY ANALYSIS

Name of Task: HIT MOVING TARGET

SUBTASKS	VIGS	BOT	M55	BRW	V/BRW	M60A1
1. Gunner indexes ammunition.						
2. Gunner turns on main gun switch.						
3. Gunner announces IDENTIFIED.						
4. Gunner applies lead in direction of target apparent motion.						
5. Gunner lays crosshair leadline at center of target vulnerability						
6. Gunner makes final precise lay.						
7. Gunner announces ON THE WAY.						
8. Gunner fires main gun.						
9. Gunner announces sensing and BOT.						
10. Gunner relays (BOT).						
11. Gunner announces ON THE WAY (BOT).						
12. Gunner fires main gun (BOT).						
Total Number of 1's						
Task Communality Index						

Physical Similarity Analysis

The physical similarity analysis deals with the similarity between physical characteristics of the training device and those of the operational situation. The assessment is based on the physical similarity (such as location, appearance, and feel). Ignore, for now, the amount and quality of information.

For each subtask, rate each relevant control and display to describe how well the control or display is represented in the training device. Base your physical similarity ratings on the following four-point scale:

PHYSICAL SIMILARITY RATING SCALE

Rating	Definition
3	Identical. The trainee would not notice a difference between the training device control or display and the operational control or display at the time of transfer. Note that they need not be absolutely identical, but there must be no noticeable difference for the trainee.
2	Similar. The trainee would notice a difference at the time of transfer, but he would be able to perform the task. There might be a decrement in performance at transfer, but any such decrement would be readily overcome.
1	Dissimilar. There would be a large noticeable difference, quite apparent to the trainee at transfer, and a large performance decrement, given that the trainee could perform at all. Specific instruction and practice would be required on the operational equipment after transfer to overcome the decrement.
0	The control or display is not represented at all in the training device.

The ratings will be averaged for each subtask. Leave the columns for subtask means empty.

PHYSICAL SIMILARITY ANALYSIS

Name of Task: HIT MOVING TARGET

REQUIRED TASK CONTROLS (C) AND DISPLAY (D) BY SUBTASK	VIGS		BOT		M55		BRW		V/BRW		M60A1	
	Sim*	Subtask Mean	Sim*	Subtask Mean	Sim*	Subtask Mean	Sim*	Subtask Mean	Sim*	Subtask Mean	Sim*	Subta: Mean
1. GUNNER INDEXES AMMUNITION												
C_1 Ammunition selector handle												
D_1 Earphones (GUNNER, SABOT, MOVING TANK)												
D_2 Ammunition display window												
2. GUNNER TURNS ON MAIN GUN SWITCH												
C_2 Main gun switch												
D_1 Earphones (GUNNER, SABOT MOVING TANK)												
D_3 Main gun switch light												
3. GUNNER ANNOUNCES IDENTIFIED												
C_3 Microphone (IDENTIFIED)												
D_1 Earphones (GUNNER, SABOT, MOVING TANK)												
D_4 M-32 sight (eyepiece, headrest, 8X magnification)												
D_5 Moving target												
4. GUNNER APPLIES LEAD												
C_4 Gunner's control handles												
C_5 Magnetic brake palm switches												
D_4 M-32 sight												
D_6 Reticle												
D_5 Moving target												
5. GUNNER LAYS CROSSHAIR LEADLINE												
C_4 Gunner's control handles												
C_5 Magnetic brake palm switches												
D_4 M-32 sight												
D_6 Reticle												
D_5 Moving target												

* Similarity

PHYSICAL SIMILARITY ANALYSIS
(Continued)

Name of Task: HIT MOVING TARGET

REQUIRED TASK CONTROLS(C) AND DISPLAY(D) BY SUBTASK	VIGS Sim*	VIGS Subtask Mean	BOT Sim*	BOT Subtask Mean	M55 Sim*	M55 Subtask Mean	BRW Sim*	BRW Subtask Mean	V/BRW Sim*	V/BRW Subtask Mean	M60A1 Sim*	M60A1 Subtas Mean
6. GUNNER MAKES FINAL PRECISE LAY												
C_4 Gunner's control handles												
C_5 Magnetic brake palm switches												
D_4 M-32 sight												
D_6 Reticle												
D_5 Moving target												
7. GUNNER ANNOUNCES ON THE WAY												
C_3 Microphone (ON THE WAY)												
C_4 Gunner's control handles												
C_5 Magnetic brake palm switches												
D_1 Earphones (UP, FIRE)												
D_4 M-32 sight												
D_5 Moving target												
D_6 Reticle												
8. GUNNER FIRES MAIN GUN												
C_4 Gunner's control handles												
C_5 Magnetic brake palm switches												
C_6 Firing triggers												
D_4 M-32 sight												
D_5 Moving target												
D_6 Reticle												
9. GUNNER ANNOUNCES SENSING AND BOT												
D_4 M-32 sight												
C_4 Gunner's control handles												
C_5 Magnetic brake palm switches												
C_3 Microphone (OVER, SHORT, DOUBTFUL, TARGET, LEFT, RIGHT, LINE, BOT)												
D_6 Reticle												
D_5 Moving target												

* Similarity

PHYSICAL SIMILARITY ANALYSIS
(Continued)

Name of Task: HIT MOVING TARGET

REQUIRED TASK CONTROLS(C) AND DISPLAY(D) BY SUBTASK	VIGS Sim*	VIGS Subtask Mean	BOT Sim*	BOT Subtask Mean	M55 Sim*	M55 Subtask Mean	BRW Sim*	BRW Subtask Mean	V/BRW Sim*	V/BRW Subtask Mean	M60A1 Sim*	M60A1 Subtas Mean
10. GUNNER RELAYS (BOT)												
C_4 Gunner's control handles												
C_5 Magnetic brake palm switches												
D_4 M-32 sight												
D_5 Moving target												
D_6 Reticle												
11. GUNNER ANNOUNCES ON THE WAY (BOT)												
C_3 Microphone (ON THE WAY)												
C_4 Gunner's control handles												
C_5 Magnetic brake palm switches												
D_1 Earphones (UP)												
D_4 M-32 sight												
D_5 Moving target												
D_6 Reticle												
12. GUNNER FIRES MAIN GUN (BOT)												
C_4 Gunner's control handles												
C_5 Magnetic brake palm switches												
C_6 Firing triggers												
D_4 M-32 sight												
D_5 Moving target												
D_6 Reticle												

* Similarity

Functional Similarity Analysis

The functional similarity analysis is based on the numbers of alternatives which each display or control may assume. The alternatives in the device are compared with the alternatives in the operational system.

For each display and control, first determine the number of alternatives in the operational environment. This is often a straight-forward decision. For example, the ammunition index handle on the computer of an operational tank has six positions. You should enter a "6" on the worksheet. But sometimes there are an indeterminant number of alternatives. For example, a target may be moving in any of 360 directions at up to 35 different speeds. In these cases use your expertise to identify the number of states (direction by speed) that change the procedure (in this case, initial sight picture) for the task.

Next determine the number of alternatives in the training device. Do not consider the similarity between the device and the operational environment. Even if the computer on the device has buttons instead of a handle, enter the number of alternatives presented by the buttons. Try to base your estimate of indeterminant cases on the known alternatives the devices present. If the alternatives for the device are unknown, consider the number of alternatives possible within the inherent constraints of the device.

Repeat the process for each display and control for each subtask. The number of alternatives for a given control or display may vary depending on the subtask.

FUNCTIONAL SIMILARITY ANALYSIS

Name of Task: HIT MOVING TARGET

REQUIRED TASK CONTROLS(C) AND DISPLAY(D) BY SUBTASK	VIGS Alternatives	BOT Alternatives	M55 Alternatives	BRW Alternatives	V/BRW Alternatives	M60A1 Alternatives
1. GUNNER INDEXES AMMUNITION						
C_1 Ammunition selector handle						
D_1 Earphones (GUNNER, SABOT, MOVING TANK)						
D_2 Ammunition display window						
2. GUNNER TURNS ON MAIN GUN SWITCH						
C_2 Main gun switch						
D_1 Earphones (GUNNER, SABOT, MOVING TANK)						
D_3 Main gun switch light						
3. GUNNER ANNOUNCES IDENTIFIED						
C_3 Microphone (IDENTIFIED)						
D_1 Earphones(GUNNER, SABOT, MOVING TANK)						
D_4 M-32 sight (eyepiece, headrest, 8X magnification)						
D_5 Moving target						
4. GUNNER APPLIES LEAD						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
D_4 M-32 sight						
D_6 Reticle						
D_5 Moving target						
5. GUNNER LAYS CROSSHAIR LEADLINE						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
D_4 M-32 sight						
D_6 Reticle						
D_5 Moving target						

FUNCTIONAL SIMILARITY ANALYSIS

Name of Task: HIT MOVING TARGET

REQUIRED TASK CONTROLS (C) AND DISPLAY (D) BY SUBTASK	VIGS Alternatives	BOT Alternatives	M55 Alternatives	BRW Alternatives	V/BRW Alternatives	M60A1 Alternatives
6. GUNNER MAKES FINAL PRECISE LAY						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
D_4 M-32 sight						
D_6 Reticle						
D_5 Moving target						
7. GUNNER ANNOUNCES ON THE WAY						
C_3 Microphone (ON THE WAY)						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
D_1 Earphones (UP, FIRE)						
D_4 M-32 sight						
D_5 Moving target						
D_6 Reticle						
8. GUNNER FIRES MAIN GUN						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
C_6 Firing triggers						
D_4 M-32 sight						
D_5 Moving target						
D_6 Reticle						
9. GUNNER ANNOUNCES SENSING AND BOT						
D_4 M-32 sight						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
C_3 Microphone (OVER, SHORT, DOUBTFUL, TARGET, LEFT, RIGHT, LINE, BOT)						
D_6 Reticle						
D_5 Moving target						

FUNCTIONAL SIMILARITY ANALYSIS

Name of Task: HIT MOVING TARGET

REQUIRED TASK CONTROLS (C) AND DISPLAY (D) BY SUBTASK	VIGS Alternatives	BOT Alternatives	M55 Alternatives	BRW Alternatives	V/BRW Alternatives	M60A1 Alternatives
10. GUNNER RELAYS (BOT)						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
D_4 M-32 sight						
D_5 Moving target						
D_6 Reticle						
11. GUNNER ANNOUNCES ON THE WAY (BOT)						
C_3 Microphone (ON THE WAY)						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
D_1 Earphones (UP)						
D_4 M-32 sight						
D_5 Moving target						
D_6 Reticle						
12. GUNNER FIRES MAIN GUN (BOT)						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
C_6 Firing triggers						
D_4 M-32 sight						
D_5 Moving target						
D_6 Reticle						

Learning Deficit Analysis

The benefits of a training device depends in part on the level of performance the trainee would probably have before formal training and the level he would need to perform the task in the operational environment. The learning deficit analysis addresses that relationship. This analysis requires you to perform three procedures:

- Rate the level of the skills and knowledge related to the task that the trainee would probably have prior to training.
- Determine the level of skills and knowledges the trainee would need to perform the task.
- Estimate the amount of time required to train the skills and knowledges to the level required by the task.

First estimate the amount of each skill or knowledge the average trainee would have upon his first exposure to the training system. In this case the average trainee is a high school graduate in Armor OSUT. He has completed the common soldier and the tank driver blocks of instruction. Rate his likely level of proficiency on each skill and knowledge on the following five point Repertory Scale (RS):

REPERTORY SCALE

Rating	Definition
4	Has a complete understanding of the skill or knowledge. Can do the steps in this subtask that require the skill or knowledge completely and accurately without supervision.
3	Understands this skill or knowledge but may require supervision to do the steps in this subtask that require the skill or knowledge. Level of proficiency equals what would be expected after several practice trials of the step.
2	Is familiar with this skill or knowledge, but would require assistance on the steps in this subtask that require the skill or knowledge. Level of proficiency equals what would be expected from a complete briefing and one performance of the task step.
1	Has a limited experience or familiarity with this skill or knowledge. Level of proficiency equals what would be expected from an orientation.
0	No experience or familiarity with this skill or knowledge. Cannot perform a task step requiring this skill or knowledge.

Next, determine the amount of each skill and knowledge required to perform the task. In this case the task requires hitting moving targets from stationary and moving tanks, within 10 seconds, 70% of the time. Base your ratings on the following five-point Criterion Scale (CS):

CRITERION SCALE

Rating	Definition
4	Should be able to apply skill or knowledge under all conditions without hesitation. System will not tolerate errors.
3	Should be able to apply skill or knowledge under most conditions without hesitation. System will not tolerate infrequent errors.
2	Should have skill or knowledge equivalent to briefing and some practice but does not need to be able to apply knowledge or skill without error. System will tolerate occasional errors.
1	Should have skill or knowledge equivalent to briefing on knowledge or on performance of skill. System will tolerate frequent errors.

The last factor for the Learning Deficit Analysis is the amount of time that would be required to train a person to the required CS level for each subtask. Assume that all training will be performed dry-fire on a tank. Targets will be 8' x 8' panels on a track. For each subtask list the number of minutes required under those conditions to take a trainee from his entry (RS) level to the required (CS) level.

KNOWLEDGES AND SKILLS BY SUBTASK	Repertory	Criterion	Minutes To Train
1. GUNNER INDEXES AMMUNITION.			
K_1 Knows procedure to index ammunition (including when to index ammunition)	____	____	____
2. GUNNER TURNS ON MAIN GUN SWITCH			
(None)			
3. GUNNER ANNOUNCES IDENTIFIED			
K_2 Knows that saying IDENTIFIED is response to TC saying GUNNER, (AMMO TYPE), (TARGET TYPE) and Gunner seeing the target	____	____	____
S_1 Is able to distinguish between targets and friendlies	____	____	____
4. GUNNER APPLIES LEAD			
K_3 Knows number of lead lines for ammunition types	____	____	____
K_4 Knows number of lead lines for speed of target	____	____	____
S_2 Is able to estimate speed of target	____	____	____
S_3 Is able to maintain smooth track	____	____	____
5. GUNNER LAYS CROSSHAIR LEADLINE			
K_5 Knows crosshair leadline is placed on target's center of mass (with lead applied)	____	____	____
S_3 Is able to maintain smooth track	____	____	____
6. GUNNER MAKES FINAL PRECISE LAY			
K_5 Knows crosshair leadli is placed on target's center of mass (with lead applied)	____	____	____
S_3 Is able to maintain smooth track	____	____	____
7. GUNNER ANNOUNCES ON THE WAY			
K_6 Knows that saying ON THE WAY is response to crosshair leadline being on target's center of mass, TC saying FIRE, and Loader saying UP	____	____	____
S_3 Is able to maintain smooth track	____	____	____
8. GUNNER FIRES MAIN GUN			
S_3 Is able to maintain smooth track	____	____	____
9. GUNNER ANNOUNCES SENSING AND BOT			
K_7 Knows that sensing is mental notation of the point in the sight reticle where burst of round appears as it passes, strikes short of, or hits the target.	____	____	____
K_8 Knows there are three deflection sensings (LEFT, RIGHT, LINE) and four range sensings (SHORT, OVER, DOUBTFUL, TARGET)	____	____	____
K_9 Knows that saying BOT is response to sensing round	____	____	____
S_4 Is able to sense rounds	____	____	____

LEARNING DEFICIT ANALYSIS
(Continued)

KNOWLEDGES AND SKILLS BY SUBTASK	Repertory	Criterion	Minutes To Train
10. GUNNER RELAYS (BOT)			
K_{10} Knows to move point of sight reticle by most direct route from where burst of round appears to target's center of mass	_____	_____	_____
S_2 Is able to estimate speed of target	_____	_____	_____
S_3 Is able to maintain smooth track	_____	_____	_____
11. GUNNER ANNOUNCES ON THE WAY (BOT)			
K_{11} Knows that saying ON THE WAY is response to point of sight reticle where burst of round appears being on target's center of mass and Loader saying UP	_____	_____	_____
S_3 Is able to maintain smooth track	_____	_____	_____
12. GUNNER FIRES MAIN GUN (BOT)			
S_3 Is able to maintain smooth track	_____	_____	_____

Training Techniques Analysis

This part of the analysis considers the adequacy of the training techniques possible on the training device. Complete a worksheet for each subtask. First, decide which taxonomic categories apply to the subtask. The categories are defined and illustrated in Table 1 of this appendix. Several categories may apply to a subtask.

Next rate the extent to which the principles relevant to the categories have been incorporated in the device. The principles relevant to each category have already been identified on each worksheet. Rate each principle in each category. The principles are defined and illustrated in each category. The principles are defined and illustrated in Appendix A of this workbook. Base your ratings on the following seven-point scale:

TRAINING TECHNIQUE SCALE

Rating	Definition
3	Optimal implementation of this technique; in complete accord with this principle.
2	Good implementation of this technique; in excellent accord with this principle.
1	Fair implementation of this technique; good accord with this principle.
0	This priinciple or technique was inapplicable or irrelevant.
	or
	The device neither implemented this technique nor violated this principle.
-1	Mild violation of this training principls; implementation of a mildly opposing technqiue.
-2	Serious violation of this principle or technique.
-3	Complete violation of this principle; implementation of a strongly contraindicated technique.

Training Techniques Analysis

This part of the analysis considers the adequacy of the training techniques possible on the training device. Complete a worksheet for each subtask. First, decide which taxonomic categories apply to the subtask. The categories are defined and illustrated in Table 1. Several categories may apply to a subtask.

Next rate the extent to which the principles relevant to the categories have been incorporated in the device. Rate each principle in each category. The principles are defined and illustrated in Appendix A. Base your ratings on the following seven-point scale:

TRAINING TECHNIQUE SCALE

Rating	Definition
3	Optimal implementation of this technique; in complete accord with this principle.
2	Good implementation of this technique; in excellent accord with this principle.
1	Fair implementation of this technique; good accord with this principle.
0	This principle or technique was inapplicable or irrelevant. or The device neither implemented this technique nor violated this principle.
-1	Mild violation of this training principle; implementation of a mildly opposing technique.
-2	Serious violation of this principle or technique.
-3	Complete violation of this principle; implementation of a strongly contraindicated technique.

TRAINING TECHNIQUES ANALYSIS

Subtask: GUNNER INDEXES AMMUNITION

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
☐ 2. Recalling procedures	2 4 5 6 7 8 9		1 2 3 26 29 31		1 2 3 29 30	
☐ 3. Non-verbal identification	10 11 12 35		4 5 26		1 4 5 27 29 30	
☐ 4. Non-verbal detection	13 14		6		6 29 30	
☐ 5. Using principles interpreting, inferring	15 16 36		7 17 18 19 29 30		7 27 29 30	
☐ 6. Making decisions	17 18 19 20 21 36		1 7 8 9 17 18 19 29 30		8 29 30	

Subtask: GUNNER INDEXES AMMUNITION

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 7. Continuous movement	22 23 24 25 35 36		10 11 17 20 22 23 24 27 28 31		9 10 15 17 19 22 23 24 25 26 27 28 29 30	
☐ 8. Verbal detection and identification	2 4 5 26		1 12		11 29 30	
☐ 9. Positioning and serial movement	27 28 35 36		1 13 21 23 24 25 27 28 31		9 12 15 16 17 18 19 20 21 22 23 24 26 27 28 29 30	

Subtask: GUNNER INDEXES AMMUNITION

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 10. Repetitive movement	29 30 31 35		18 20 23 24 25 27 28 31		9 15 17 18 19 20 21 22 23 24 26 27 28 29 30	
☐ 11. Written verbalization	32 33		1 9		13 29 30	
☐ 12. Oral verbalization	29		14 15 16 22		14 29 30	
☐ 13. Other verbalization, including signs	33 34		1 9 18		14 29 30	

Subtask: GUNNER TURNS ON MAIN GUN SWITCH

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
☐ 2. Recalling procedures	2 4 5 6 7 8 9		1 2 3 26 29 31		1 2 3 29 30	
☐ 3. Non-verbal identification	10 11 12 35		4 5 26		1 4 5 27 29 30	
☐ 4. Non-verbal detection	13 14		6		6 29 30	
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☐ 6. Making decisions	17 18 19 20 21 36		1 7 8 9 17 18 19 29 30		8 29 30	

Subtask: GUNNER TURNS ON MAIN GUN SWITCH

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Subtask: GUNNER TURNS ON MAIN GUN SWITCH

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Subtask: GUNNER ANNOUNCES IDENTIFIED

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
☐ 2. Recalling procedures	2 4 5 6 7 8 9		1 2 3 26 29 31		1 2 3 29 30	
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Subtask: GUNNER ANNOUNCES IDENTIFIED

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Subtask: GUNNER ANNOUNCES IDENTIFIED

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Subtask: GUNNER APPLIES LEAD

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
☐ 2. Recalling procedures	2 4 5 6 7 8 9		1 2 3 26 29 31		1 2 3 29 30	
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Subtask: GUNNER APPLIES LEAD

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Subtask: GUNNER APPLIES LEAD

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
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Subtask: GUNNER LAYS CROSSHAIR LEADLINE

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
☐ 2. Recalling procedures	2 4 5 6 7 8 9		1 2 3 26 29 31		1 2 3 29 30	
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Subtask: GUNNER LAYS CROSSHAIR LEADLINE

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 7. Continuous movement	22 23 24 25 35 36		10 11 17 20 22 23 24 27 28 31		9 10 15 17 19 22 23 24 25 26 27 28 29 30	
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Subtask: GUNNER LAYS CROSSHAIR LEADLINE

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 10. Repetitive movement	29 30 31 35		18 20 23 24 25 27 28 31		9 15 17 18 19 20 21 22 23 24 26 27 28 29 30	
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Subtask: GUNNER MAKES FINAL PRECISE LAY

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
☐ 2. Recalling procedures	2 4 5 6 7 8 9		1 2 3 26 29 31		1 2 3 29 30	
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Subtask: GUNNER MAKES FINAL PRECISE LAY

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
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Subtask: GUNNER MAKES FINAL PRECISE LAY

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 10. Repetitive movement	29 30 31 35		18 20 23 24 25 27 28 31		9 15 17 18 19 20 21 22 23 24 26 27 28 29 30	
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Subtask: GUNNER ANNOUNCES ON THE WAY

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
☐ 2. Recalling procedures	2 4 5 6 7 8 9		1 2 3 26 29 31		1 2 3 29 30	
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Subtask: GUNNER ANNOUNCES ON THE WAY

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Subtask: GUNNER ANNOUNCES ON THE WAY

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Subtask: GUNNER FIRES MAIN GUN

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
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☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
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Subtask: GUNNER FIRES MAIN GUN

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Subtask: GUNNER FIRES MAIN GUN

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Subtask: GUNNER ANNOUNCES SENSING AND BOT

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
☐ 2. Recalling procedures	2 4 5 6 7 8 9		1 2 3 26 29 31		1 2 3 29 30	
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Subtask: GUNNER ANNOUNCES SENSING AND BOT

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 7. Continuous movement	22 23 24 25 35 36		10 11 17 20 22 23 24 27 28 31		9 10 15 17 19 22 23 24 25 26 27 28 29 30	
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Subtask: GUNNER ANNOUNCES SENSING AND BOT

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 10. Repetitive movement	29 30 31 35		18 20 23 24 25 27 28 31		9 15 17 18 19 20 21 22 23 24 26 27 28 29 30	
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Subtask: GUNNER RELAYS (BOT)

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
☐ 2. Recalling procedures	2 4 5 6 7 8 9		1 2 3 26 29 31		1 2 3 29 30	
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Subtask: GUNNER RELAYS (BOT)

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
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Subtask: GUNNER RELAYS (BOT)

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
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Subtask: GUNNER ANNOUNCES ON THE WAY (BOT)

Task-Taxonomic Label	PRINCIPLES - TECHNIQUES					
	Stimulus #	Rating	Response #	Rating	Feedback #	Rating
☐ 1. Recalling facts and principles	1 2 3 4 5		1 2 3 26 31		1 2 27 29 30	
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Subtask: GUNNER ANNOUNCES ON THE WAY (BOT)

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Subtask: GUNNER ANNOUNCES ON THE WAY (BOT)

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Subtask: GUNNER FIRES MAIN GUN (BOT)

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Subtask: GUNNER FIRES MAIN GUN (BOT)

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Subtask: GUNNER FIRES MAIN GUN (BOT)

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TASK-TAXONOMIC LABELS AND DEFINITIONS

1. Recalling Facts & Principles
   a. Common behavior attributes:
      1. Concerns verbal or symbolic learning.
      2. Concerns acquisition and long term maintenance of knowledge so that it can be recalled.
   b. Common examples:
      1. Recalling equipment nomenclature or functions.
      2. Recalling system functions, such as the complex relations between system input and output.

2. Recalling Procedures
   a. Common behavioral attributes:
      1. Concerns verbal or symbolic behavior.
      2. Concerns acquisition and long term maintenance of knowledge so that it can be recalled.
      3. Concerns the chaining or sequencing of events.
   b. Common examples:
      1. Recalling equipment assembly and disassembly procedures.
      2. Recalling the operating or checkout procedures for a piece of equipment (Cockpit check lists).

3. Non-Verbal Identification
   a. Common behavioral attributes:
      1. Pattern recognition approach to identification - <u>not problem solving</u>.
      2. Classification by non-verbal characteristics.
      3. Status determination - ready to start.
   b. Common examples:
      1. Classify a sonar target as "sub" or "non-sub."
      2. Visual classification of flying aircraft as "friend" or "enemy" or as an "F-4."

4. Non-Verbal Detection
   a. Common behavior attributes:
      1. Vigilance - detect a few cues embedded in a large block of time.
      2. Low threshold detections - early detection of very small cues.
      3. Scan for wide range of possible cues.
   b. Common examples:
      1. Detect targets in background noise on radar/sonar scopes.
      2. Visually detect submarine periscope at sea (snorkeling).

5. Using Principles, Interpreting, Inferring
   a. Common behavior attributes:
      1. Use of logic and/or natural law, and/or known relationships.
      2. Limited uncertainty of outcome.
      3. Usually little thought of other alternatives.
      4. Usually related to on-going tasks.
   b. Common examples:
      1. Diagnosis of equipment malfunctions by using scientific laws or principles.
      2. Dealing with the impact of natural forces in shiphandling - tides, currents, weather, momentum.

6. Making Decisions
   a. Common behavioral attributes:
      1. Choosing a course of action when alternatives are given, unspecified or unknown.
      2. A successful course of action is not readily apparent.
      3. The penalties for unsuccessful courses of action are not readily apparent.
      4. The relative value of possible decisions must be considered - including possible trade-offs.
      5. Frequently involves forced decisions made in a short period of time with soft information.
   b. Common examples:
      1. Choosing frequencies to search in an ECM search plan.
      2. Choosing torpedo attack.

7. Continuous Movement
   a. Common Behavioral Attributes:
      1. Tracking, dynamic control: a perceptual-motor skill involving continuous pursuit of a target or keeping dials at a certain reading such as maintaining constant turn rates, etc.
      2. Compensatory movements based on feedback from displays.
      3. Skill in tracking requires smooth muscle coordination patterns - lack of overcontrol.
      4. Involves estimating changes in positions, velocities, accelerations, etc.
      5. Involves knowledge of display-control relationships.
      6. May involve scanning of complex displays to determine current status of system, and to predict the evolving state of the system.
   b. Common examples:
      1. Submarine bow and stern planes operators maintaining a constant course, or making changes in course or depth.
      2. Tank driver following a road.

8. Verbal Detection And Identification
   a. Common behavioral attributes:
      1. Involves the recognition of symbols, spoken or written language, or codes, diagrams, schematics, technical symbology, etc.
      2. Symbols to be identified typically are of low meaningfulness to untrained personnel.
      3. More cognitive than sensory - identification or interpretation is emphasized.
      4. Involves storing queues of symoblic information and meanings and the recognizing of these symbols and/or meanings.
      5. Basic components of most tasks.
   b. Common examples:
      1. Monitoring communication channels.
      2. Reading schematics symbols.

9. Positioning And Serial Movement
   a. Common behavioral attributes:
      1. Positioning switches, push buttons, knobs, levers, etc., either individually or in sequence.
      2. Highly coordinated motor tasks such as key board operations.
      3. Motor aspects of equipment set-up and operating procedures.
      4. Proprioceptive feedback is important.
   b. Common examples:
      1. Following equipment turn-on procedures - emphasis on motor behavior.
      2. Typing or operation of computer terminal - card punch operation.

10. Repetitive Movement
    a. Common behavioral attributes:
        1. Perceptual-motor behavior-emphasis on motor. Premium on manual dexterity, occasionally strength and endurance.
        2. Repetitive mechanical skill.
        3. Standardized behavior, little room for variation or innovation.
        4. Automatic behavior, low level of attention is required in skilled operator. Kinesthetic cues dominate control of behavior.
        5. Fatigue or boredom may become a factor when skill is performed over an extended period of time or at a rapid rate.
        6. Fine tolerances.
        7. Often a component of a larger task.
    b. Common examples:
        1. Use of hand tools such as hammer, saw, wrench or power tools such as lathes, or grinders.
        2. Running a drill press in an assembly line.

11. Written Verbalization
    a. Common behavioral attributes:
        1. Creating an alpha-numeric statement.
        2. Frequently involves use of a formal or special language such as used to input data into a computer.
        3. Less spontaneous than oral communication; more time is available to construct verbalization.
        4. To translate an event into an alpha-numeric description.
    b. Common examples:
        1. Shipboard log keeping.
        2. Status board updating.

12. Oral Verbalization
    a. Common behavioral attributes:
        1. Speaking natural or specilized languages.
        2. Often involves the use of a specific message model. - Standard vocabulary and format.
        3. Also concerns clarity of voice, enunciation, speed, volume, etc.
        4. Timing of verbalization is usually critical - when to pass information.
        5. Typically characterized by redundancy in terms of information content.
        6. Involves extensive use of previously overlearned verbal skills, or overcoming overlearned interfering patterns.
    b. Common examples:
        1. Officer giving oral orders.
        2. Sonar operator passing oral information over communication net.

13. Other Verbalization, Including Signs
    a. Common behavioral attributes:
        1. Communication other than oral or written.
        2. Use of sign language such as hand signals.
        3. Special emphasis on the motor skill required to execute sign language such as semaphore.
    b. Common examples:
        1. LSO use of signals to communicate with pilot making carrier landing.
        2. Traffic police directing traffic at a busy intersection.

APPENDIX A

TRAINING TECHNIQUES AND PRINCIPLES

Stimulus Considerations

1. Organize training around intrinsic cue components (key words, formuli, or key letters) within the fact or principle. Use these cue components as mediators to trigger recall of complete facts or principles.

2. Use mnemonics (associating recall of facts or principles with imagery, rhyme, rhythm, etc.).

3. Prevent decay of recall by increasing the meaningfulness of the material to be learned by providing organization to the related facts or principles.

4. Prevent decay of recall by overlearning the original material.

5. Prevent decay of recall by providing periodic refresher training.

6. Use mental rehearsal of sequential steps, if readily codable in symbolic form (mediators).

7. Maximize control of cues to ensure that the trainee if forming the proper associations, i.e., responding appropriately to the correct cues.

8. In training for recall of lengthy or difficult procedures, develop redundant cue response patters (via primary and supplementary stimuli) to trigger the sequentially next correct response.

9. Use programmed demonstration of procedures, up to but not beyond ability of student to understand procedures.

10. Stimuli used in training should be nearly identical to job stimuli unless this fidelity increases problem difficulty in the initial phase of training to an unacceptable level.

11. Vary ratio of relevant and irrelevant (transient) stimuli according to requirements of various stages of training. Maximize relevant cues and minimize irrelevant cues in early stages of training; use a realistic mix of relevant and irrelevant cues in final stages of training.

12. Emphasize cues which elicit mediating responses, e.g., "self-instructions," "population stereotypes" and "natural associations."

13. Transfer increases as the difference between reference and generalization stimulus decreases.

14. Decrease signal-to-noise ratio as student achieves success at a given difficulty level.

15. Emphasize the logical relationships which exist between the general principle and the specific application. The unique or special features of each application should be minimized while the common relationships to the general principle should be emphasized.

16. Stimulus redundancy - apply principle in a large number of practice situations, while varying the stimulus context of repetitions.

17. Trainees must have access to potentially relevant data. In final stage of training, data should be limited to that expected in real world situation.

18. Guiding - early in training present logical implications of alternative choices.

19. Mediators - acquisition and use of mediators such as stereotypes or self-instructions facilitate the identification of response alternatives and the probability of success of each alternative.

20. Stimulus load - toward the end of training, present trainee with a realistic data processing load (realistic number of significant signals plus realistic noise in real time.)

21. Stimulus generalization - vary the stimulus context of repetitions.

22. Insure that the appropriate stimulus cues are available to the trainee continually during the performance of the task.

23. Emphasis on prediction of future states (thinking ahead).

24. Expose trainee to a wide range of task difficulty.

25. In continuous control tasks, high fidelity is often required in (1) stimulus presentation, (2) operator response characteristics, and (3) dynamic system behavior, the evolving display-control relationship.

26. Contiguity - the symbol and referent should be presented in close temporal contiguity.

27. Cue development - emphasize the development and use of internal cues, such as mediators or kinesthetic cues.

28. In training for lengthy serial movements, provision should be made for programming demonstrations of the lengthy serial or sequential performance according to the amount of demonstration which can be understood by the trainee. Continuing a demonstration beyond the "saturation point" will result in the association of responses with incorrect cues.

29. Early training - use models of correct performance as a basis for trainee to perceive critical cues of good form. Use models of component parts of task.

30. Cue discrimination - perceive difference between correct and incorrect form.

31. Later stages of training - the kinesthetic cues dominate (cues based on "muscle feel").

32. Performance aids - especially in early phase of training use a performance aid or model, such as instructions, checklists or standard examples/formats to aid in perceiving need for and composing of messages.

33. "In-the-head" mediators - in later stages of instruction rely on "in-the-head" instructions, models, etc., to aid in perceiving need for and composing required messages.

34. Static and dynamic models - in early phase of training use models, such as still and moving graphic displays (video tape recordings) to establish the characteristics of criterion performance.

35. Pre-training methods need to take care not to make the S dependent upon the extra cues provided in the early stages of training and thus to hinder the changeover to more direct relations between input and output at a later stage.

36. With very complex tasks, instruction in principles yields better results than laying down a detailed drill, while with simpler tasks the drill is at least equally effective.

Response Considerations

1. Make an overt response indicating the recall of facts and principles, enabling measures. (Add appropriate phrase for each behavioral category.)

2. Response Generalization - make job performance type responses (i.e., high fidelity responses later in training).

3. Guide or prompt response, especially in the acquisition phase of training.

4. To-be-learned response should occur as soon as relevant cues are perceived (contiguous occurrences of cues and response).

5. The strength of a given response typically increases as a function of practice.

6. To enable reinforcement of performance, the student, upon detecting a signal, should respond so that what is detected and time of detection can be recorded.

7. Performance differences which are due to individual differences in ability tend to be magnified as a function of increasing task difficulty. Identical performance among given trainees is not necessarily indicative of identical learning, hence the need for a better measure of the extent to which trainees are profiting from the training situation.

8. Apply decision making in a large number of practice situations while varying the stimulus context of repetitions.

9. Stress - when trainee will be required to perform under stress, use overlearning of skill to minimize effects of competing responses.

10. Repetition: highly skilled performance requires extensive practice.

11. Make an objective measurement of the frequency and type of errors - changes in total error pattern - throughout the course of training. Measurement should be based on specific behavioral objectives.

12. Symbol - referent associations (pairings) are especially amenable to "in-the-head" practice.

13. Emphasize extensive motor response repetition or practice in order to (1) strengthen individual or component steps of the movement series, and (2) integrate these steps into a smooth sequence.

14. Emphasize overt respondings in a social context. Practice to strengthen correct responses.

15. Record responses in context. Since the response is typically complex involving subtle relations among components, the technique of measurement should provide for recording the total complex in a manner that permits analysis of such subtle relationships.

16. When skill is not regularly used, prevent decay of recall by providing periodic refresher training.

17. The usefulness (for "lateral" transfer) of any learned capability will be increased if it is practiced in as wide a variety of situations as possible.

18. Ensure that relevant subordinate capabilities have been thoroughly learned before calling on vertical (e.g., inclusion) transfer to aid the learning of "advanced" capabilities.

19. Vertical transfer is enhanced by the variety of previous knowledge.

20. Where the whole task is a closely coordinated activity such as aiming a rifle or stimulated flying of an aircraft, it is better to tackle the task as a whole. Any attempt to divide it up tends to destroy the proper coordination of action and subordination of individual actions to the requirements of the whole, and thus outweighs any advantage there might be in mastering different portions of the task separately.

21. Where the task involves a series of component actions which have to be performed in the correct order but each is largely independent of the others, there seem to be advantages in practicing the different components separately.

22. Continuous practice facilitates mastery of complex, meaningful material and the establishment of coordinated rhythmic activity (within limits of fatigue).

23. Continuous practice seems to be preferred by older trainees.

24. Spaced practice is more efficient than continuous if only the actual duration of the sessions is counted and the time between sessions is ignored. When the time between sessions is included, continuous practice is usually more efficient.

25. Very brief pauses between practice sessions should be as effective as longer ones.

26. "Mental practice" in which the S performs a task in the imagination, can often be substituted for a substantial amount of practice involving full performance with little if any loss of effectiveness.

27. Relatively little learning occurs if Ss are passive spectators or even passive performers, but that they must be involved in active decisions and choices about what they are doing, and it is these that they will retain whether they are right or wrong.

28. If two or more tasks have to be learned, it is most beneficial to begin with the one which elicits the greatest care and effort towards the attainment of a high standard of performance. However, if S was not allowed to continue to practice the more difficult task until a point of reasonable mastery, he would be left with an inadequate comprehension of the task, and transfer to a simpler task might be confused and less satisfactory than if he had tackled the easier task first.

29. The more sub-tasks there are in the overall task, and the more they interact with one another, the more opportunity there will be for improvement, and therefore the longer improvement will continue.

30. Transfer of skill from one task to another will depend not so much upon the extent to which methods possible for one are applied to the other, but the extent to which methods which have been selected for the one are applied to the other.

31. Effectiveness of spacing practice depends on what is done during the times between practice periods: (a) If they are spent in rehearsal of the material, learning will benefit, unless the task is fatiquing in which case continued practice may depress subsequent performance, (b) If time between practice periods are spent on another task, learning or later recall of the first task may be impaired, the degree of impairment depending on the degree of similarity between the two tasks.

Feedback Considerations

1. Schedule KOR (knowledge of results) soon after response for maximum reinforcement. Error identification function of KOR is significant.

2. Especially early in training, use KOR after the response to each step, for maximum reinforcement. Error identification function of KOR is significant. In later stages of training, step feedback is not so critical.

3. As training progresses, gradually increase the delay in presenting KOR (present KOR in increments of 2 steps, then 3 steps, etc.) until the schedles of KOR approximates the operational setting.

4. Immediate reinforcement (0.5 second delay) for non-verbal identification.

5. KOR - automatic system performance feedback (e.g., if target is identified from partial cues, present the target with a full set of cues after identification; automate if possible).

6. Feedback omission schedule programmed according to stage of training: high feedback during initial stages, decreased to equivalent to operational setting or lower.

7. Schedule KOR soon after response for maximum reinforcement. KOR should deal with both process and solution.

8. Early in training, evaluate each alternative solution as it is identified, and when a final choice among alternatives is made, evaluate the overall choice.

9. Shaping - reinforcement should be contingent upon characteristics of trainee's response so that by a process of 'successive approximations,' the final desired proficiency is produced.

10. Continuous KOR - because of the dynamic nature of the problem, the trainer should at times be presented with an on-going evaluation of his performance.

11. Incorrect as well as correct symbol-referent pairing can be strengthened by self-initiated "in-the-head" practice.

12. Extensive response repetition (overlearning) by the trainee to take advantage of the built-in feedback properties of these types of tasks. Simple repetitive movements may be "automatically" reinforcing (Kinesthetic feedback.)

13. Provide record of trainee's overt response to enable evaluation of trainee performance (i.e., must know what Ss are doing in order to provide KOR).

14. Analyze oral verbalization recordings to evaluate trainer/team performance and provide KOR.

15. Performance improvement in acquisition depends on knowledge of results (KOR). The rate of improvement depends upon the precision of KOR (within limits of meaningfulness).

16. Delay of KOR has little or no effect on acquisition (for simple motor movements only).

17. Increasing the post-KOR interval up to a point will improve performance level in acquisition (spacing during practice). The "point" is when recall of movement or KOR is affected.

18. The type of activity in the KOR delay or post-KOR delay interval does not influence acquisition (provided the intervening activity is not of the same type).

19. Withdrawal of KOR produces deterioration of performance when level of training is low or moderate.

20. When KOR is delayed in acquisition, and S engages in deliberate verbal or motor activity during the delay interval, the effect of KOR withdrawal is poorer performance than when S rests.

21. When KOR is delayed in acquisition, and S rests during the delay interval, the effect on performance when KOR is withdrawn is no different than when immediate KOR is used.

22. Activity in the post-KOR delay interval during acquisition worsens performance when KOR is withdrawn.

23. After a relatively large amount of training, learning can continue when KOR is withdrawn.

24. If errors could be prevented in the first few trials (e.g., guidance) mastery of the task should be very much quicker.

25. Guidance during training is beneficial when tracking movements have to be made with an incompatible control-display relationship.

26. Guidance does not aid simple repetitive movements, but aids learning complex courses.

27. The manner of conveying KOR is important: (a) Effectiveness is greatest when the information is clearly and simply related to the action performed. Any distortion or equivocation in the information fed back to the S will reduce its effectiveness. (b) Unduly full or complex information may be partly ignored or may confuse the S. (c) The information given should indicate the discrepancy between what is required and what has been achieved rather than merely give a reminder of requirements or some broad measure of achievement.

28. Performance is best maintained when the conditions are such as to emphasize the need for S to observe the feel of his actions in order to relate then to their results.

29. A S must have some cues to the results of his actions if he is to perform accurately at all, and training procedures will be effective in so far as they help him to observe and use such cues as are inherent in the task for which he is being trained. They will fail in so far as they provide him with extra cues on which he comes to rely but which are not available when he changes from training to the actual job.

30. KOR acts as an incentive.

APPENDIX B

TVII WORKBOOK

TV 11

Task Commonality Analysis

The purpose of the task commonality analysis is to describe the overlap in training content between the operational situation and the training device. Commonality is said to exist when a subtask can be performed and practiced in the training situation (with the device) and in the operational situation.

Rate each subtask on the following two-point scale:

Rating	Definition
1	Training device permits practice of the subtask.
0	Training device does not permit practice of the subtask.

TASK COMMONALITY ANALYSIS

Name of Task: HIT MOVING TARGET

REQUIRED TASK ELEMENTS	VIGS	BOT	M55	BRW	V/BRW	M60A1
1. Gunner indexes ammunition						
2. Gunner turns on main gun switch						
3. Gunner announces IDENTIFIED						
4. Gunner applies lead in direction of target apparent motion						
5. Gunner lays crosshair leadline at center of target vulnerability						
6. Gunner makes final precise lay						
7. Gunner announces ON THE WAY						
8. Gunner fires main gun						
9. Gunner announces sensing and BOT						
10. Gunner relays (BOT)						
11. Gunner announces ON THE WAY(BOT)						—
12. Gunner fires main gun (BOT)						
Task Commonality Index						

$$\text{Task Commonality Index} = \frac{\text{\# of 1's for Device}}{\text{\# Rq'd Task Elements}}$$

Physical Similarity Analysis

The physical similarity analysis deals with the similarity between physical characteristics of the training device and those of the operational situation. The assessment is based on the physical similarity (such as location, appearance, and feel). Ignore, for now, the amount and quality of information.

Rate relevant control and display to describe how well the control or display is represented in the training device. Base your physical similarity ratings on the following four-point scale:

PHYSICAL SIMILARITY RATING SCALE

Rating	Definition
3	Identical. The trainee would not notice a difference between the training device control or display and the operational control or display at the time of transfer. Note that they need not be absolutely identical, but there must be no noticeable difference for the trainee.
2	Similar. The trainee would notice a difference at the time of transfer, but he would be able to perform the task. There might be a decrement in performance at transfer, but any such decrement would be readily overcome.
1	Dissimilar. There would be a large noticeable difference, quite apparent to the trainee at transfer, and a large performance decrement, given that the trainee could perform at all. Specific instruction and practice would be required on the operational equipment after transfer to overcome the decrement.
0	The control or display is not represented at all in the training device.

PHYSICAL SIMILARITY ANALYSIS

Name of Task: HIT MOVING TARGET

REQUIRED TASK CONTROLS AND DISPLAYS	VIGS	BOT	M55	BRW	V/BRW	M60A1
C_1 Ammunition selector handle						
C_2 Main gun switch						
C_3 Microphone						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
C_6 Firing triggers						
D_1 Earphones						
D_2 Ammunition display window						
D_3 Main gun switch light						
D_4 M-32 sight (eyepiece, headrest, 8X magnification)						—
D_5 Moving target						
D_6 Reticle						
Sum of Physical Similarity Ratings						
Physical Similarity Index						

$$\text{Physical Similarity Index} = \frac{\text{Sum of Similarity Ratings for Device}}{3\ (\#\ \text{of Rq'd Controls \& Displays})}$$

Functional Similarity Analysis

The functional similarity analysis compares the operator's behavior in terms of the information flow from each display to the operator, and from the operator to each control. The assessment is made in terms of the amount of information transmitted from each display to each control and the type of information-processing activity performed by the operator. The issue is not the physical fidelity of a control or display but whether the operator acts on the same amount of information in the same way in both the operational and the training situation.

For each control and display estimate the number of states (or discrete values) which the display or control may assume in the training device. Then compare the number of states in the training situation with the device to the corresponding number in the operational situation.

For each required task control or display, rate how well it is functionally represented in each training device. Base your functional similarity ratings on the following four-point scale:

FUNCTIONAL SIMILARITY RATING SCALE

Rating	Definition
3	Identical. The number of states in the training situation is the same as the number of states in the operational setting.
2	Similar. The number of states in the training situation is at least half of the number of states in the operational setting.
1	Dissimilar. The number of states in the training situation is less than half of the number of states in the operational setting.
0	Missing. The control or display is not represented at all in the training device.

FUNCTIONAL SIMILARITY ANALYSIS

Name of Task: HIT MOVING TARGET

REQUIRED TASK CONTROLS AND DISPLAYS	VIGS	BOT	M55	BRW	V/BRW	M60A1
C_1 Ammunition selector handle						
C_2 Main gun switch						
C_3 Microphone						
C_4 Gunner's control handles						
C_5 Magnetic brake palm switches						
C_6 Firing triggers						
D_1 Earphones						
D_2 Ammunition display window						
D_3 Main gun switch light						
D_4 M-32 sight (eyepiece, headrest, 8X magnification)						
D_5 Moving target						—
D_6 Reticle						
Sum of Functional Similarity Ratings						
Functional Similarity Index						

$$\text{Functional Similarity Index} = \frac{\text{Sum of Similarity Ratings for Device}}{3\ (\#\ \text{of Rq'd Controls and Displays})}$$

Skills and Knowledges Requirements

The skills and knowledges requirements analysis assesses the skills and knowledges in the student's repertory before training and compares them to the skills and knowledges required for successful performance of the task.

For each skill and knowledge, estimate how much of the skill or knowledge the average trainee could be expected to have on first exposure to the training device. Assume that the average trainee is a high school graduate in Armor OSUT who has completed common soldier and tank driver blocks of instruction. Base your ratings on the following scale:

RATING SCALE FOR SKILLS AND KNOWLEDGES BEFORE TRAINING

Rating	Definition
4	Has a complete understanding of the skill or knowledge. Can do the steps in this subtask that require the skill or knowledge completely and accurately without supervision.
3	Understands this skill or knowledge but may require supervision to do the steps in this subtask that require the skill or knowledge. Level of proficiency equals what would be expected after several practice trials of the step.
2	Is familiar with this skill or knowledge, but would require assistance on the steps in this subtask that require the skill or knowledge. Level of proficiency equals what would be expected from a complete briefing and one performance of the task step.
1	Has a limited experience or familiarity with this skill or knowledge. Level of proficiency equals what would be expected from an orientation.
0	No experience or familiarity with this skill or knowledge. Cannot perform a task step requiring this skill or knowledge.

Next, rate the amount of each skill and knowledge the trainee must have to do the task (hit moving targets as a gunner) in the operational situation. Base your ratings on the following scale:

RATING SCALE FOR SKILLS AND KNOWLEDGES AFTER TRAINING

Rating	Definition
4	Should be able to apply skill or knowledge under all conditions without hesitation. System will not tolerate errors.
3	Should be able to apply skill or knowledge under most conditions without hesitation. System will not tolerate infrequent errors.
2	Should have skill or knowledge equivalent to briefing and some practice but does not need to be able to apply knowledge or skill without error. System will tolerate occasional errors.
1	Should have skill or knowledge equivalent to briefing on knowledge or on performance of skill. System will tolerate frequent errors.

Leave the column for Difference (After-Before) blank.

SKILL AND KNOWLEDGE REQUIREMENTS ANALYSIS

Name of Task: HIT MOVING TARGET

REQUIRED TASK SKILL AND KNOWLEDGE	AFTER TRAINING	BEFORE TRAINING	DIFFERENCE (AFTER-BEFORE)
S_1 Is able to distinguish between targets and friendlies			
S_2 Is able to estimate speed of target			
S_3 Is able to maintain smooth track			
S_4 Is able to sense rounds			
K_1 Knows procedure to index ammunition (including when to index ammunition)			
K_2 Knows that saying IDENTIFIED is response to TC saying GUNNER, (AMMO TYPE), (TARGET TYPE) and Gunner seeing the target			
K_3 Knows number of lead lines for ammunition types.			
K_4 Knows number of lead lines for speed of target			
K_5 Knows crosshair leadline is placed on target's center of mass (with lead applied)			
K_6 Knows that saying ON THE WAY is response to crosshair leadline being on target's center of mass, TC saying FIRE, and Loader saying UP			
K_7 Knows that sensing is mental notation of the point in the sight reticle where burst of round appears as it passes, strikes short of, or hits the target.			
K_8 Knows there are three deflection sensings (LEFT, RIGHT, LINE) and four range sensings (SHORT, OVER, DOUBTFUL, TARGET)			
K_9 Knows that saying BOT is response to sensing round			
K_{10} Knows to move point of sight reticle by most direct route from where burst of round appears to target's center of mass			
K_{11} Knows that saying ON THE WAY is response to point of sight reticle where burst of round appears being on target's center of mass and Loader saying UP			
Total Difference Score			
Skill & Knowledge Requirements Index			

Skill & Knowledge Requirements Index = $\frac{\text{Total Difference Score}}{4(\text{Number of Skills and Knowledges})}$

Task Training Difficulty

The task training difficulty analysis estimates the difficulty (in terms of training time) of training soldiers to perform the required tasks successfully. Assign ratings based on the assumption that training occurs on the operational equipment. In this case, operational equipment is a tank, dry fire, with moving targets (8x8 panels).

For each required task element, rate the amount of training time for surmounting its associated deficit relative to the most time-consuming task element. Base your task training difficulty ratings on the following five-point scale:

TASK TRAINING DIFFICULTY RATING SCALE

Rating	Definition
4	Requires as much time to train as the most time-consuming task element.
3	Requires substantial training time, but less than above.
2	Requires a moderate amount of training time relative to the most time-consuming task element.
1	Requires only minimal training time relative to the most time-consuming task element.
0	Requires no training time.

TASK TRAINING DIFFICULTY ANALYSIS

Name of Task: HIT MOVING TARGET

REQUIRED TASK ELEMENTS	TRAINING DIFFICULTY
1. Gunner indexes ammunition	
2. Gunner turns on main gun switch	
3. Gunner announces IDENTIFIED	
4. Gunner applies lead in direction of target apparent motion	
5. Gunner lays crosshair leadline at center of target vulnerability	
6. Gunner makes final precise lay	
7. Gunner announces ON THE WAY	
8. Gunner fires main gun	
9. Gunner announces sensing and BOT	
10. Gunner relays (BOT)	
11. Gunner announces ON THE WAY (BOT)	
12. Gunner fires main gun (BOT)	
Total Training Difficulty Score	
Task Training Difficulty Index = $\frac{\text{Total Training Difficulty Score}}{4(\text{Number of Task Elements})}$	

APPENDIX C

TVIV WORKBOOK

Coverage Requirement Analysis

The purpose of the Coverage Requirement (CR) Analysis is to determine which skills and knowledges must be covered by a training device. The skills and knowledges for the task are listed on the worksheet. Assume that the device is to be used in OSUT training. Trainees will have completed driving segments but will not have had any gunnery training. Rate each skill and knowledge on the following scale:

Rating	Definition
1	Required in training.
0	Not required in training.

Coverage Analysis

The purpose of the Coverage (C) Analysis is to determine whether a device provides training for each skill and knowledge. Rate each skill and knowledge for each device on the following scale:

Rating	Definition
1	Provides training coverage for the skill/knowledge.
0	Does not provide training coverage for the skill/knowledge.

Rate all skills and knowledges for a device before you rate any skill or knowledge for another device.

COVERAGE REQUIREMENT (CR) AND COVERAGE (C) WORKSHEET

SKILLS AND KNOWLEDGES	CR	C					
		VIGS	BOT	M55	BRW	V/BRW	M60A1
S_1 Is able to distinguish between targets and friendlies							
S_2 Is able to estimate speed of target							
S_3 Is able to maintain smooth track							
S_4 Is able to sense rounds							
K_1 Knows procedure to index ammunition (including when to index ammunition)							
K_2 Knows that saying IDENTIFIED is response to TC saying GUNNER, (AMMO TYPE), (TARGET TYPE) and Gunner seeing the target							
K_3 Knows number of lead lines for ammunition types							
K_4 Knows number of lead lines for speed of target							
K_5 Knows crosshair leadline is placed on target's center of mass (with lead applied)							
K_6 Knows that saying ON THE WAY is response to crosshair leadline being on target's center of mass, TC saying FIRE, and Loader saying UP							
K_7 Knows that sensing is mental notation of the point in the sight reticle where burst of round appears as it passes, strikes short of, or hits the target							
K_8 Knows there are three deflection sensings (LEFT, RIGHT, LINE) and four range sensings (SHORT, OVER, DOUBTFUL, TARGET)							
K_9 Knows that saying BOT is response to sensing round							
K_{10} Knows to move point of sight reticle by most direct route from where burst of round appears to target's center of mass							
K_{11} Knows that saying ON THE WAY is response to point of sight reticle where burst of round appears being on target's center of mass and Loader saying UP							

Training Proficiency Analysis

The purpose of the Training Proficiency (P) Analysis is to determine the degree of proficiency the trainee must attain at the end of training. First, cross out any skills or knowledges that you decided did not need to be trained (CR=0). Rate each remaining skill and knowledge on the following scale:

Rating	Definition
4	Should be able to apply skill or knowledge under all conditions without hesitation. System will not tolerate errors.
3	Should be able to apply skill or knowledge under most conditions without hesitation. System will not tolerate infrequent errors.
2	Should have skill or knowledge equivalent to briefing and some practice but does not need to be able to apply knowledge or skill without error. System will tolerate occasional errors.
1	Should have skill or knowledge equivalent to briefing on knowledge or on performance of skill. System will tolerate frequent errors.

Learning Difficulty Analysis

The purpose of the Learning Difficulty (D) Analysis is to determine the degree of difficulty associated with learning each required (CR=1) skill and knowledge. Assume that the trainee is a high school graduate in Armor OSUT. He has completed driving training but has no experience with gunnery. The training program will consist of classroom instruction and dry-fire with an M60A1 tank and moving 8x8 panels. Rate the difficulty of training each skill or knowledge in such a program using the following scale:

Rating	Definition
1	Easy. Trainee can accomplish the activity once informed that it exists; no practice or study is required.
2	Modestly Difficult. Trainee can accomplish most of the activity after classroom instruction; some of the activity requires minimal skill practice or study for acquiring the needed level of proficiency.
3	Difficult. Trainee can accomplish the activity only if classroom instruction is accompanied by practice or study.
4	Highly Difficult. Trainee can accomplish the activity only if classroom instruction is accompanied by extensive practice or study.

TRAINING PROFICIENCY (P) AND LEARNING
DIFFICULTY (D) WORKSHEET

SKILLS AND KNOWLEDGES	P	D
S_1 Is able to distinguish between targets and friendlies		
S_2 Is able to estimate speed of target		
S_3 Is able to maintain smooth track		
S_4 Is able to sense rounds		
K_1 Knows procedure to index ammunition (including when to index ammunition)		
K_2 Knows that saying IDENTIFIED is response to TC saying GUNNER, (AMMO TYPE), (TARGET TYPE) and Gunner seeing the target		
K_3 Knows number of lead lines for ammunition types		
K_4 Knows number of lead lines for speed of target		
K_5 Knows crosshair leadline is placed on target's center of mass (with lead applied).		—
K_6 Knows that saying ON THE WAY is response to crosshair leadline being on target's center of mass, TC saying FIRE, and Loader saying UP		
K_7 Knows that sensing is mental notation of the point in the sight reticle where burst of round appears as it passes, strikes short of, or hits the target.		
K_8 Knows there are three deflection sensings (LEFT, RIGHT, LINE) and four range sensings (SHORT, OVER, DOUBTFUL, TARGET)		
K_9 Knows that saying BOT is response to sensing round		
K_{10} Knows to move point of sight reticle by most direct route from where burst of round appears to target's center of mass		
K_{11} Knows that saying ON THE WAY is response to point of sight reticle where burst of round appears being on target's center of mass and Loader saying UP		

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS

The purpose of the Physical Characteristics Analysis is to assess how well the physical characteristics of a device support good instructional practice. You must complete a worksheet for each relevant skill and knowledge (CR=1) if any device being considered covers the skill or knowledge (C=1). The worksheet includes ratings for each device.

First decide which one of the following categories best describes learning for the skill or knowledge:

BEHAVIORAL CATEGORIES
(1) Rule Learning and Using
(2) Classifying - Recognizing Patterns
(3) Identifying Symbols
(4) Detecting
(5) Making Decisions
(6) Recalling Bodies of Knowledge
(7) Performing Gross Motor Skills
(8) Steering and Guiding - Continuous Movement
(9) Positioning Movement and Recalling Procedures
(10) Voice Communications

The categories are defined and illustrated in Appendix A. List the category in column I.

Next determine which learning guidelines in Appendix B apply to the physical characteristics for the generic type of device for training the behavior. The guidelines are grouped by behavioral categories. The guidelines that might apply to physical characteristics are labelled P or P/F. Some of the guidelines may not apply to a training device for an entry level gunner. List the guidelines that do apply in column II of the worksheet. Include the number and an abbreviated statement of each relevant guideline.

For each device, list the displays and controls that contribute to training the skill or knowledge. If the device does not cover the skill or knowledge (C=0), enter NONE. Put these entries in column III of the worksheet.

The next step is to determine which characteristics of the relevant displays and controls contribute to training the skill or knowledge. Review the generic stimulus characteristics that are listed in column IV of the worksheet (and defined in Table 1) to find which ones apply to the stimulus. More than one characteristic may apply. Cross out the characteristics that do not apply. Also determine which response mode is required by the device. The response modes are listed and defined in Table 1. Only one response mode may apply. List the best description of the response mode in column IV.

Next rate each relevant characteristic for each device that covers the skill or knowledge on how well it incorporates the learning guidelines you listed in column II. Rate each applicable characteristic on the following scale:

Rating	Definition
0	Extremely deficient implementation of guidelines (or) no implementation at all.
1	Partially proficient implementation of guidelines; at least minimal implementation is achieved.
2	Proficient implementation of guidelines; implementation is adequate to good instructional quality.
3	Highly proficient implementation of guidelines; implementation is of exceptional quality (or) is identical with guidelines.

When you assign a rating to a characteristic, calculate an approximate average of how well the characteristic implements the complete set of guidelines in column II. Leave the blocks for PC Score blank.

Functional Characteristics Analysis

The Functional Characteristics Analysis is an extension of the Physical Characteristics Analysis.

The first step in this analysis is to extract the learning guidelines related to functional characteristics from Appendix B. The candidate guidelines are in Appendix B under the behavioral category you entered in column I. This time you are concerned with the guidelines labelled P/F or F. List the guidelines that apply to a training device for entry level gunners in column VI of the worksheet.

Then rate each device that covers the skill or knowledge (C=1) on how well it applies each guideline. Rate the device for each guideline on the following scale:

Rating	Definition
0	Extremely deficient implementation of guideline (or) no implementation at all.
1	Partially proficient implementation of guideline; at least minimal implementation is achieved.
2	Proficient implementation of guideline; implementation is adequate to good in quality.
3	Highly proficient implementation of guideline; implementation is of high exceptional quality (or) identical with guideline.

Enter your ratings in column VII. Leave the FC Score boxes blank.

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: S_1 Is able to distinguish between targets and friendlies

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: S_1 Is able to distinguish between targets and friendlies

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

Skill/Knowledge: S_2 Is able to estimate speed of target

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Rating: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: S_2 Is able to estimate speed of target

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: S_3 Is able to maintain smooth track

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: S_3 Is able to maintain smooth track

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Rating: BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: S_4 Is able to sense rounds

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Rating: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: S_4 Is able to sense rounds

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_1 Knows procedure to index ammunition (including when to index ammunition)

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_1 Knows procedure to index ammunition (including when to index ammunition)

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_2 Knows that saying IDENTIFIED is response to TC saying GUNNER, (AMMO TYPE), (TARGET TYPE) and Gunner seeing the target

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Rating: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_2 Knows that saying IDENTIFIED is response to TC saying GUNNER, (AMMO TYPE), (TARGET TYPE) and Gunner seeing the target

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_3 Knows number of lead lines for ammunition types

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_3 Knows number of lead lines for ammunition types

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_4 Knows number of lead lines for speed of target

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_4 Knows number of lead lines for speed of target

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

...ii/Knowledge: K_5 Knows crosshair leadline is placed on target's center of mass (with lead applied)

I	II	III	IV	V	VI	VII		
...avioral ...gory	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Rating		
						VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_5 Knows crosshair leadline is placed on target's center of mass (with lead applied)

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Rating		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_6 Knows that saying ON THE WAY is response to crosshair leadline being on target's center of mass, TC saying FIRE, and Loader saying UP

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_6 Knows that saying ON THE WAY is response to crosshair leadline being on target's center of mass, TC saying FIRE; and Loader saying UP

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_7 Knows that sensing is mental notation of the point in the sight reticle where burst of round appears as it passes, strikes short of, or hits the target.

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_7 Knows that sensing is mental notation of the point in the sight reticle where burst of round appears as it passes, strikes short of, or hits the target

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_8 Knows there are three deflection sensings (LEFT, RIGHT, LINE) and four range sensings (SHORT, OVER, DOUBTFUL, TARGET).

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_8 Knows there are three deflection sensings (LEFT, RIGHT, LINE) and four range sensings (SHORT, OVER, DOUBTFUL, TARGET)

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

II/Knowledge: K_9 Knows that saying BOT is response to sensing round

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Rating: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_9 Knows that saying BOT is response to sensing round

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_{10} Knows to move point of sight reticle by most direct route from where burst of round appears to target's center of mass

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_{10} Knows to move point of sight reticle by most direct route from where burst of round appears to target's center of mass

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_{11} Knows that saying ON THE WAY is response to point of sight reticle where burst of round appears being on target's center of mass and Loader saying UP

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Rating: VIGS	BOT	M55
		• VIGS	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• BOT	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M55	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score		FC Score			

PHYSICAL CHARACTERISTICS AND FUNCTIONAL CHARACTERISTICS WORKSHEET

Skill/Knowledge: K_{11} Knows that saying ON THE WAY is response to point of sight reticle where burst of round appears being on target's center of mass and Loader saying UP

I	II	III	IV	V	VI	VII		
Behavioral Category	Learning Guidelines-Physical (P and P/F)	Displays/ Controls	Generic Characteristics	PC Rating	Learning Guidelines-Functional (F and P/F)	Functional Ratings		
						BRW	V/BRW	M60A1
		• BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• V/BRW	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode PC Score					
		• M60A1	• Stimulus 1. Visual form 2. Visual movement 3. Visual spectrum 4. Scale 5. Audio 6. Tactile-Kinesthetic • Response Mode					

TABLE 1

GENERIC STIMULUS CHARACTERISTICS AND
CORRESPONDING TRAINEE RESPONSE MODES

STIMULUS CAPABILITIES [1]

(1) VISUAL FORM

1.1 Visual Alphanumeric - words, numbers and other symbols presented graphically.

1.2 Visual Pictorial, Plane - a two-dimensional image, a representation in the form of a photograph or drawing.

1.3 Visual Line Construction, Plane - a two-dimensional figure made of lines, such as a mathematical curve or graph.

1.4 Visual Object, Solid - a three-dimensional image or reality that is viewed from exterior perspectives.

1.5 Visual Environment - A three-dimensional image or reality that is viewed from inside.

(2) VISUAL MOVEMENT

2.1 Visual Still - a static visual field, as with a still photograph, drawing, or printed page.

2.2 Visual Limited Movement - a basically static visual field with elements that can be made to move, as with an animated transparency or simple panel with switches that move.

2.3 Visual Full Movement - a visual field in which all elements can move, as with a motion picture, flight simulator, or operational aircraft.

2.4 Visual Cyclic Movement - a visual field which moves through a fixed sequence and then repeats the sequence in a repetitive manner, as with a film loop.

(3) VISUAL SPECTRUM

3.1 Black and White - a visual field composed of either black or white elements, as with the printed page or line drawings.

3.2 Gray Scale - a visual field composed of black, white and continuous gradations of gray, as with a black and white photograph or television picture.

3.3 Color - a visual field composed of various segments of the visual spectrum, as with color television or motion pictures.

(4) SCALE

4.1 Exact Scale - actual visual field or a one-to-one replication of that field as with a full-sized mock-up, simulator, or operational system.

4.2 Proportional Scale - a representation of reality in other than full scale, such as a scaled model map or photograph.

(5) AUDIO

5.1 Voice Sound Range - a limited quality of sound which enables spoken words to be used as the medium of communications, but not suited to more demanding tasks, such as music or sound recognition exercises.

5.2 Full Sound Range - a quality of sound reproduction that contains all the significant elements of the sound and is suited to the demanding task of sound recognition exercises.

5.3 Ambient Sounds - a complex sound environment with sounds emanating from various sources and from various directions, including background noise and task significant sounds.

(6) TACTILE-KINESTHETIC

6.1 Tactile Cues - signals received through the sense of touch, including sensations related to texture, size or shape.

6.2 Internal Stimulus Motion Cues - the sensations felt by a person when he moves his arm, leg, fingers, etc.

6.3 External Stimulus Motion Cues - the sensations felt by a person who he is moved by some outside force in such a way that his body experiences roll, pitch, yaw, heave, sway and/or surge.

TRAINEE RESPONSE MODE [2]

(1) Covert Response - a response which the trainee creates in his mind but does not express in an observable manner.

(2) Multiple Choice - a response mode in which a trainee selects a response from a limited set of responses.

(3) Pre-Programmed Verbal Performance - a response mode in which a trainee creates a short answer to a question having a limited set of correct answers.

(4) Free-Style Written Performance - a response mode in which a trainee writes a response in his own words.

(5) Decision Indicator - a verbal or perceptual motor response in which the trainee indicates that he has made a divergent type decision.

(6) Voice Performance - a response mode in which a trainee speaks, including conversation.

(7) Fine Movement Manipulative Acts - a response mode in which a trainee makes discrete and small movements of dials, switches, keys or makes sensitive adjustments to instruments. Act may involve use of small instruments.

(8) Broad Movement Manipulative Acts - a response mode in which a trainee makes large movements of levers or wheels on large pieces of equipment or by the use of equipment or by the use of hand held tools.

(9) Tracking - a response mode in which a trainee continuously controls a constantly changing system, such as steering an automobile or holding a compass bearing in steering a ship.

(10) Procedural Manipulative Acts - a response mode in which a trainee performs the sequence of steps in a procedure, such as in the carrying out of the items on the checklist for pre-flighting an aircraft or turning on a radar system.

[1] From just a few to many of these capabilities may apply to the device/control being characterized.

[2] Only one type of response will be made by the trainee to the corresponding stimulus.

Behavioral Category Definitions
(Adapted From TRADOC Pam. 350-30)

Behavioral Category Definitions

(Types of Learning)

Behavioral Category #1 -- Rule Learning and Using

- SAMPLE ATTRIBUTES
  1. Choosing a course of action based on applying known rules.
  2. Frequently involves "If--then" situations.
  3. The rules are not questioned, the decision focuses on whether the correct rule is being applied.
- EXAMPLES
  1. Apply the "rules of the road".
  2. Solve mathematical equations (both choosing correct equations and the mechanics of solving the equation).
  3. Carrying out military protocol.
  4. Selection of proper fire extinguisher for different types of fires.
  5. Choosing correct grammar in novel situations covered by rules.

Behavioral Category #2 -- Classifying-Recognizing Patterns

- SAMPLE ATTRIBUTES
  1. Pattern recognition approach to identification -- not problem solving.
  2. Classification by non-verbal characteristics.
  3. Status determination -- ready to start.
  4. Object to be classified can be viewed from many perspectives or in many forms.

- EXAMPLES

1. Classify a sonar target as "sub" or "non-sub".
2. Visual classification of flying aircraft as "friend" or "enemy" or as an "F-4".
3. Determining that an identified noise is a wheel bearing failure not a water pump failure by rating the quality of the noise--not by the problem solving approach.

Behavioral Category #3 -- Identifying Symbols

- SAMPLE ATTRIBUTES

1. Involves the recognition of symbols such as in codes, diagrams, schematics, etc.
2. Symbols to be identified typically are of low meaningfulness to untrained persons.
3. Identification, not interpretation, is emphasized.

- EXAMPLES

1. Reading electronic symbols on a schematic drawing.
2. Identifying map symbols.
3. Reading and transcribing symbols on a tactical status board.
4. Identifying symbols on a weather map.

Behavioral Category #4 -- Detecting

- SAMPLE ATTRIBUTES

1. Vigilance--detect a few cues embedded in a large block of time.
2. Low threshold cues; signal to noise ratio may be very low; early awareness of small cues.
3. Scan for a wide range of cues for a given "target" and for different types of "targets".

- EXAMPLES

1. Early sonar detection of a submarine target.
2. Visually detecting the periscope of a snorkeling submarine during daytime.
3. Detect, through a slight change in sound, a bearing starting to burn out in a power generator.

Behavioral Category #5 -- Making Decisions

- SAMPLE ATTRIBUTES

1. Choosing a course of action when alternatives are unspecified or unknown.
2. A successful course of action is not readily apparent.
3. The penalties for unsuccessful course of action are not readily apparent.
4. The relative value of possible decisions must be considered -- including possible trade-offs.

- EXAMPLES

1. Choosing torpedo settings during a torpedo attack.
2. Threat evaluation and weapon assignment.
3. Choice of tactics in combat--wide range of options.
4. Choosing a diagnostic strategy in dealing with a malfunction in a complex piece of equipment.
5. Choosing to abort or commit oneself to land upon reaching the critical point in the glidepath.

Behavioral Category #6 -- Recalling Bodies of Knowledge

- SAMPLE ATTRIBUTES

1. Concerns verbal or symbolic learning.
2. Concerns acquisition and long-term maintenance of knowledge so that it can be recalled.

- EXAMPLES

1. Recalling equipment nomenclature or functions.
2. Recalling system functions, such as the complex relations between system input and output.
3. Recalling physical laws, such as Ohm's Law.
4. Recalling specific radio frequencies and other discrete facts.

Behavioral Category #7 -- Performing Gross Motor Skills

- SAMPLE ATTRIBUTES

1. Perceptual motor behavior; emphasis on motor. Premium on manual dexterity, occasionally strength and endurance.
2. Repetitive mechanical skills.
3. Standardized behavior, little room for variation or innovation.
4. Automatic behavior--low level of attention is required in skilled operator. Kinesthetic cues dominate control of behavior.
5. Fatigue or boredom may become a factor when skill is performed over an extended period of time or at a rapid rate.
6. Fine tolerances.
7. Often a component of a larger task.

- EXAMPLES

1. Use of hand tools such as hammer, saw, wrench, or power tools such as lathes or grinders.
2. Running a drill press in an assembly line.
3. Loading ammunition into artillery pieces of 5" guns.
4. Drafting--use of drafting instruments.
5. Painting--house painting or preserving ship hull, etc.
6. Marching--close order drill.

Behavioral Category =8 -- Steering and Guiding-Continuous Movement

- SAMPLE ATTRIBUTES

  1. Tracking, dynamic control--a perceptual motor skill involving continuous pursuit of a target or keeping dials at a certain reading such as maintaining constant turn rates, etc.
  2. Compensatory movements based on feedback from displays.
  3. Skill in tracking requires smooth muscle coordination patterns--lack of overcontrol.
  4. Involves estimating changes in positions, velocities, accelerations, etc.
  5. Involves knowledge of display-control relationships.

- EXAMPLES

  1. Submarine bow and stern planes operators maintaining a constant course, or making changes in course or depth.
  2. Tank driver following a road.
  3. Sonar operator keeping the cursor on a sonar target.
  4. Air-to-air gunnery--target tracking.
  5. Aircraft piloting such as visually following a ground path.
  6. Helmsman holding a course with gyro or magnetic compass.

Behavioral Category #9 -- Positioning movement and recalling procedures

- SAMPLE ATTRIBUTES

  1. Concerns the chaining or sequencing of events.
  2. Includes both the cognitive and motor aspects of equipment set-up and operating procedures.
  3. Procedural check lists are frequently used as job aids.

- EXAMPLES

1. Recalling equipment assembly and disassembling procedures.
2. Recalling the operation and check out procedures for a piece of equipment (cockpit check lists).
3. Following equipment turn-on procedures--emphasis on motor behavior.

Behavioral Category #10 -- Voice Communicating

- SAMPLE ATTRIBUTES

1. Speaking and listening in specialized languages.
2. Often involves the use of a specific message model. Standard vocabulary and format.
3. Also concerns clarity of voice, enunciation and speed.
4. Timing of verbalization if usually critical--when to pass information.
5. Typically characterized by redundancy in terms of information content.
6. Involves extensive use of previously overlearned verbal skills, or overcoming overlearned interfering patterns.
7. Tasks may be difficult due to background noises.

- EXAMPLES

1. Officer giving oral orders and receiving reports.
2. Sonar operator passing oral information over communications net.
3. Instructions by ground control operator to pilot in landing aircraft.

Learning Guidelines

for

Good Instructional Practice

Extracted from TRADOC Pam 350-30,
Interservice Procedures for Instructional
System Development, Phase III

LEARNING GUIDELINES

Behavioral Category #1 - Rule Learning and Using

P (1) Pick out the features of the real world job environment which could be used to trigger the trainee's recall of training material which must be used in the rule using part of his job.

P/F (2) Where possible, supply students with diagrams, pictures, charts, graphs, rhymes, key words, and other association devices which the student can use to relate what he already knows to what he is trying to learn.

P/F (3) Encourage students to make up their own association devices if they can and want to do it.

F (4) Where the learner is having a difficult time trying to learn and apply a rule, use specific questions which will help the learner to state the elements and relationships in the rule and thus see how concepts of the rule are related.

F (5) Provide practice until the student learns the rules and learns to apply the rules to the desired level of performance in the operational job setting.

F (6) Positive rewards of the student's correct applications of the rules learned is required in the early stages of training.

F (7) Toward the end of training, the level of positive rewards for correct performance should be reduced to the same level that the student will find on the job.

F (8) Relate the rules to be learned to operational tasks which the trainee must perform in real world assignments.

F (9) Different trainees will have different rates and styles of learning the material. Use techniques which allow students flexibility in learning time.

F (10) Reduce forgetting by providing periodic practice or refresher training for infrequently used material.

F (11) In order for slower learners to reach the same level of proficiency as faster learners, time must be allowed for the slower learner to get as many positive rewards for correct applications of the rules learned as the faster learner.

F (12) At the beginning of the training, the instructor or the material/media should clearly inform the trainee of the learning objectives; that is, what the trainee is expected to be able to do by the completion of training.

F (13) Make sure that the student can <u>recall</u> and demonstrate the concepts which make up the rule; then go on to rule learning.

F (14) Require the learner to state the rule verbally in the learner's own words. This helps the learner recall which concepts make up the rule and how the concepts are arranged.

F (15) Present examples of when the rule applies and when it doesn't.

F (16) Provide opportunities to apply the rule in a variety of new situations in which the learner has not previously been trained to apply the rule.

F (17) During practice, practical applications and practice tests, provide the student with immediate knowledge of results about his correct and incorrect answers.

F (18) Provide rewards for correct application of the rule.

F (19) To test the learner's understanding of the rule, provide an unfamiliar situation in which the rule can be applied, and then require the learner to tell how the concepts of the rule are related to each other and to this situation.

LEARNING GUIDELINES

Behavioral Category #2 - Classifying/Recognizing Patterns

P/F (1) Call student's attention to the important, distinctive features and characteristics of a pattern which distinguish this pattern from other patterns.

P/F (2) Clearly display each of the distinctive features of patterns under study. Show how these cues differ from each other (pre-differentiation of stimuli).

P/F (3) Determine if the trainee can detect distinctive features in patterns that are not to be classified or recognized (ignored) in the training task.

P/F (4) Emphasize distinctive features which can be remembered in the form of mental "pictures" instead of abstract words. When possible, supply students with diagrams, pictures, charts, graphs, rhymes, acronyms, keywords, self instructions, common associations, and other association devices like these to which the student can relate the material he is trying to learn.

P/F (5) Teach students to transform distinctive features of the patterns into items that they can readily recall and make correct actions to.

P/F (6) In instructional presentations and practice, many examples and non-examples of the pattern should be presented.

P/F (7) Toward the end of training, present examples and non-examples of patterns that will be very similar to each other in the job environment.

P/F (8) In early training there should be few irrelevant features, so that identifying the distinctive characteristics of the pattern is fairly easy.

P/F (9) By the end of training, the number of irrelevant cues surrounding distinctive characteristics should be increased to correspond with the real-life situation/job setting.

P/F (10) Provide the student with practice in recognizing examples from the full range of patterns produced by a given object. Make the examples more similar as training progresses. At the end of training, the similarities in the examples should be the similarities that exist in the real world.

P/F (11) Provide a variety of examples of the pattern. Select examples from the full range of variations in the pattern.

P/F (12) To test learning, require the trainee to provide new examples of the pattern, and to teach recognition of the pattern to someone else.

F (13) At the beginning of the training, the instructor or the materials should clearly inform the trainee of the training objectives; that is, what the trainee is expected to be able to do by the completion of training.

F (14) Organize the training material in such a way that the trainee can meet the training objectives at the end of training.

F (15) Relate the objectives and learning activities to operational tasks which the trainee must perform in future real world assignments.

F (16) Positive rewards of the students' correct recognition of patterns is required in the early stages of training.

F (17) Toward the end of training, the level of positive rewards for correct performance should be reduced to the same level that the student will find on the job.

F (18) Provide plenty of opportunities for students to practice making recognitions of each pattern being learned.

F (19) In practice and practice tests, provide for immediate knowledge of results to help the student meet the learning objectives by making each action of the task correct.

F (20) The pause <u>following</u> knowledge of results should be long enough to allow the student time to sort out his errors and pick out distinctive features of the pattern to be classified.

F (21) Different trainees will have different rates and styles of learning the material, Provide flexibility in the time allowed.

F (22) In order for slower learners to reach the same level of proficiency as faster learners, time must be allowed for

the slower learner to get as many or more positive rewards for correct answers as the faster learner.

F (23) Be sure that students develop a strong tendency to look for certain critical and distinctive patterns and develop the same kind of expectations they will need to have while on the job.

F (24) Require the student to overlearn the original material; that is, the student should continue to practice the required tasks after the point that simple mastery of the task has been met.

F (25) Reduce forgetting by providing periodic opportunity to recall and apply infrequently used material.

LEARNING GUIDELINES

Behavioral Category #3 - Identifying Symbols

P (1) Pick out features of the real world job environment which could be used to spark the trainees' recall of associated material which would likely be used in the job or its parts.

P/F (2) If there are very similar symbols (or features of parts of symbols) which have been frequently confused in the past, then be sure that the students can tell the difference between the symbols (or their parts) before they are taught actions to take for each one.

P/F (3) During instruction, the presentation of the symbol should be followed immediately by the presentation of its meaning (contiguity principle).

P/F (4) When possible, supply students with diagrams, pictures, charts, graphs, rhymes, acronyms, key words, and other association devices to which the student can relate what he is trying to learn.

F (5) Clearly relate the learning objectives and learning activities to operational tasks, which the trainee must perform in future real world assignments.

F (6) Break the overall learning task down into manageable steps or units when any of the following conditions exist:

a. lower ability students

b. complex material

c. overall task contains many small parts

F (7) Change the order of presenting material during practice so that each training item will be learned equally well.

F (8) Encourage the students to make up their own association devices if they can and want to.

F (9) When possible, provide the students with association devices which will cause an emotional reaction in the student.

F (10) Allow for self-paced practice and provide the student with knowledge of the results of his identifications.

F (11) Reduce forgetting by providing periodic recall and practice for infrequently used material.

F (12) Require the student to overlearn the original material; that is, the student should continue to practice the required tasks after the point that simple mastery of the task has been met.

F (13) Practice and test situations should require the student to make written or verbal answers so that the accuracy of his recall can be checked.

F (14) Different trainees will have different rates and styles of learning the material. Provide flexibility in learning time alotted.

F (15) Positive reward of the student's correct identification of symbols and provision of immediate knowledge of result is

required in the early stages of training.

F (16) Toward the end of training, the level of positive rewards and knowledge of results should be reduced to the same level that the student will find on the job.

Behavioral Category #4 - Detecting

P/F (1) Train student to use systematic search procedures utilizing whatever senses (sight, hearing, etc.) are appropriate for the task.

P/F (2) Provide examples of correct performance of the task where appropriate.

P/F (3) In presenting signals, sample from the full range of types of signals. Include the different signal sources to be encountered on the job and the different patterns of each signal source.

P/F (4) Train the student to use the detected signal as a cue to search for and verify the existence of the signal in a second sense modality, where it is possible for the signal to be detected by more than one sense, and when a student thinks he has detected the signal through one sense.

P/F (5) Where appropriate, train the student to use peripheral vision when scanning with the eyes.

- The following (6 - 11) are guidelines for managing <u>earlier stages</u> of training.

P/F (6) Provide a high signal density more frequent than in the operational task.

P/F (7) Signals should have high signal-to-noise ratio

P/F (8) Use different amounts of time between signal presentation.

P/F (9) Insure a high frequency of student identifications of the signal.

P/F (10) Provide student with immediate and continuous knowledge of results

P/F (11) Do not teach any vigilance techniques

- The following (12 - 16) are guidelines for managing <u>intermediate stages</u> of training.

P/F (12) Use a lower signal density

P/F (13) Use lower signal-to-noise ratios

P/F (14) Use different amounts of time between signal presentations.

P/F (15) Provide student with intermittent knowledge of results.

P/F (16) Introduce vigilance techniques

- The following (17 - 21) are guidelines for managing <u>advanced stages</u> of training.

P/F (17) Low signal density; i.e., operational density or minimum number suited to training.

P/F (18) Decrease signal-to-noise ratio to operational level

P/F (19) Use different amounts of time between signal presentations.

P/F (20) Provide the student with knowledge of results equivalent.

P/F (21) Require vigilance techniques appropriate to the job setting.

P/F (22) Train the student to monitor his own vigilance level by conditioning him to respond to biological conditions (internal cues) which appear when vigilance begins to fade.

F (23) At the beginning of the training, the instructor or the material/media should clearly inform the trainee of the learning objectives; that is, what the trainee is expected to be able to do by the completion of training.

F (24) Relate the learning objectives and learning activities to operational tasks which the trainee must perform in future real world assignments.

F (25) Train the student in techniques of vigilance; train him to establish a mental "set" to search. Use instructions to establish this "set" and provide a positive reward when the student achieves a proper "set."

F (26) Provide knowledge of results on correct detections. This can serve as positive reward to encourage vigilance behaviors that will lead to continued correct detections.

F (27) Ensure that detections <u>are correct</u> before providing positive reward.

F (28) Do not allow a student to leave one phase or level of the learning task until he has achieved the required level of mastery.

LEARNING GUIDELINES

Behavioral Category #5 - Making Decisions

P/F (1) Provide the student with a wide variety of decision making experiences. Provide basic problems where there are only a few factors to consider. Also provide complex problems which require the student to consider many factors. The solutions should range from easy to hard.

P/F (2) If the trainee will be required to make the decision under stress in the real world, then he must overlearn the decision making skill during training. That is, he must be able to make the correct decision, and he must be able to make the decision efficiently, accurately, and repeatedly in distracting surroundings.

P/F (3) During the final stages of training, it is important to provide situations which closely duplicate the real world with respect to amount of data, type of data, amount of time to complete the decision making problems, and the amount of distraction and "noise" in the working environment.

F (4) At the beginning of the training, the instructor or the materials should clearly inform the trainee of the learning objectives; that is, what the trainee is expected to be able to do by the completion of training.

F (5) At the beginning of training, relate the learning objectives and learning activities to operational tasks which the trainee must perform in future real world assignments.

F (6) For the most efficient learning of decision making the student must already have learned the technical knowledge which will allow him to identify what the problem really is, make a list of the most reasonable solutions, and determine which of the solutions would be best.

F (7) The student will learn best if he is not afraid of making incorrect decisions in the training situations; this is particularly true in the early stages of training and in very complex decision making processes. Materials and instructors should, therefore, attempt to decrease student fears to a low level.

F (8) Give the students examples of these two types of actions which are to be avoided when making decisions:

a. response biases; that is, the tendency to make a "favorite" decision or use a "favorite" solution regardless of the real nature of the problem.

b. perceptual sets; that is, the tendency to generalize problems or view several types of problems as if they were all the same when, in fact, they are quite different.

F (9) Teach the students a set of steps to follow in making decisions such as the following 5-step model:

a. Discover the existence of a problem and define it

b. Identify and collect relevant information

c. Develop reasonable solutions to the problem

1) compare alternative solutions

2) combine alternate solutions where desirable

d. Evaluate each of the proposed solutions.

1) how will each solution solve the problem?

2) will each solution bring about any additional benefits or problems?

3) rank each solution according to the results it would bring.

e. Decide on the best solution and put it into effect.

F (10) Provide the student with enough realistic information and data on which to formulate possible solutions and make final decisions. Be sure that the student makes decisions in the same variety of settings as he will face in carrying out his job.

F (11) Provide the learner with knowledge of results for each decision he makes. A recommended list of questions to ask about the learner's problem solutions follows:

a. Predictable? (Were evidences of perceptual sets shown in his solution?)

b. Perseverated? (Were evidences of response biases shown in solution?)

c. Timely? (Is this the appropriate time to execute this particular decision?)

d. Complete? (Did he consider all of the data and information?)

e. Consistent? (Is his solution compatible and relevant to the data and the available information?)

F (12) Give knowledge of results with respect to the student's decisions each time. Where possible, provide the actual consequences of the learner's decision.

LEARNING GUIDELINES

Behavioral Category #6 - Recalling Bodies of Knowledge

P (1) Arrange for features of the real world job setting to be used to trigger the trainee's recall of training material--the knowledge he needs to do the job.

P (2) Use high interest, attention-getting features of the learning materials throughout the training. Keep student attention by using learning activities which require active student participation.

P/F (3) Make the learning activities relevant by making them similar to real-life tasks that the student will be performing on the job.

P/F (4) If the real world job will present the trainee with very similar features of the job situation which will require the trainee to remember different knowledge for each feature, make sure that the trainee learns the difference between these features before he is taught which body of knowledge to associate with each feature.

P/F (5) When possible, supply students with diagrams, pictures, charts, graphs, rhymes, acronyms, key words, and other association devices to which the student can relate the facts and principles he is trying to learn and recall them more easily.

P/F (6) In early phases of training, provide the student with guides, prompts, cues, and coaching which will help him

remember the material correctly.

P/F (7) As training progresses, prompts should be reduced until it matches the level of help that will be available in the real world job setting.

P/F (8) Provide students with opportunities to practice their training tasks by setting up a wide variety of testing and practice situations which are very similar to situations the learner will encounter on the job.

P/F (9) Practice and test situations should require the student to make written or verbal answers so that the accuracy of his recall of the facts and principles he learned can be checked.

F (10) At the beginning of the training, the instructor or the material/media should clearly inform the trainee of the learning objectives; that is, what the trainee is expected to be able to do by the completion of training to meet the learning objectives.

F (11) Analyze the subject body of knowledge to detect key words, formulas or phrases. Organize the learning activities around these key items.

F (12) Before testing for recall, provide some warm-up exercises (or) an introduction to remind the student of the type of task and the type of information needed.

F (13) If it is necessary for the student to learn similar bodies of subject matter, then directly compare the

bodies when they are first presented so that the student can tell them apart (or) separate their presentation by as much time as possible to avoid confusion between them.

F (14) Encourage and give students directions to make up their own association devices if they can and want to.

F (15) When possible, provide students with association devices which will cause an emotional reaction in the student.

F (16) During the training sessions, provide the student with immediate knowledge of results about his correct and incorrect answers.

F (17) Provide positive rewards during the instruction, even during non-testing situations. Reward a student's progress, attitude, attention, mastery of an objective, etc.

F (18) In practice and practice tests, provide for immediate knowledge of results to help the student retain correct answers and eliminate incorrect answers.

F (19) Change the order of presenting the material during practice so that each item in the list will be learned equally well.

F (20) Rest periods should be provided during practice sessions according to need for rest as judged by the student and requirements of the specific learning material as judged by the instructor.

F (21) Different trainees will have different rates and styles of learning the material. Try to provide flexibility in time to learn.

F (22) In order for slower learners to reach the same level of proficiency as faster learners, time must be allowed for the slower learner to get as many or more positive rewards for correct answers as the faster learner.

F (23) As training continues, give the learner chances to compare his progress and achievement with the stated learning objectives.

F (24) Test to see that the student is able to correctly recall key features that will help him recall the knowledge he needs in performing his job.

F (25) Provide the student with practice in associating the knowledge to be learned with key features of the job setting.

F (26) Prevent forgetting by showing the meaningfulness of the material to the learner's job environment and duties. Emphasize the organization and structure of the material.

F (27) Require the student to overlearn the original material; that is, the student should continue to practice the required tasks after the point that simple mastery of the training task has been met.

LEARNING GUIDELINES

Behavioral Category #7 - Performing Gross Motor Skills

P (1) Teach the learner to tell the difference between similar external cues (conditions, features, characteristics, etc. or objects in the job environment to which the learner must respond with an appropriate action) like knowing when too much pressure is put on a power saw the wood begins to smoke.

P (2) Teach the learner to tell the difference between similar internal cues (muscular feelings inside one's body which guide the execution of a physical skill and allow automatic responses) like knowing by the "feel" of the power saw how much pressure to use without burning the wood.

P/F (3) Early in training, present immediate and specific knowledge of results to the student.

P/F (4) Early in training, present external cues that will bring out the desired responses in the student's actions.

P/F (5) Later in training, training should reduce the knowledge of performance results to on-the-job levels.

P/F (6) Later in training, training should train the student to respond to internal cues in his muscles to guide his actions in correctly performing the task.

P/F (7) If students make incorrect actions or begin to develop bad habits, a penalty is presented following these improper responses until they disappear.

P/F (3) To insure that the learner understands the required task, the training media should independently demonstrate/correct performance of the task.

P/F (9) To insure that the learner understands required subtasks, the training media should independently demonstrate component parts of the task.

P/F (10) To insure that the learner understands required task and subtasks, training media permits the instructor/student to describe and/or demonstrate the desired task and its component parts.

P/F (11) Provide for learner practice on parts (specific components) of the task for:

1) simple task-practice in entirety
2) complex task practice in parts and then in entirety

P/F (12) Provide for learner practice under varied conditions so as to:

1) facilitate the performance of the motor task
2) help adapt the performance of this task to potential environmental changes

P/F (13) Ensure that during practice the learners:

1) understand the objectives of the skill while learning
2) can observe a skilled performance of the desired task as often as necessary
3) can obtain knowledge of results concerning his performance of the task

P/F (14) Ensure that during practice the learners have short rest periods mixed in with the practice methods

F (15) Provide real life distractions, interruptions, and "noise" to the level that the person will encounter on-the-job, when and where appropriate.

F (16) At the beginning of training, the learning objective is made clear and apparent to the trainee.

F (17) At the beginning of training, the trainer clearly relates the learning objectives and learning activities to operational tasks which the trainee must perform in future real world assignments.

F (18) Feed back to student knowledge of results; student learns:

1) what he is doing right
2) what he is doing wrong

F (19) Feed back to student comparisons; student learns how what he did compares to the:

1) learning objectives of the program
2) correct demonstration of task
3) standards that are required in operational setting

F (20) The pause following knowledge of results should be long enough to allow the student time to sort out his errors and to rest his muscles.

F (21) Reward performances which are closer to the goal than the preceeding performances. In this manner, the student's performance will become successively closer to the desired performance (shaping).

F (22) After the student successfully reaches the desired performance, reduce the frequency of reward to the level found on the job.

F (23) Require the student to overlearn the original material; that is, the student should continue to perform the required tasks after the point that simple mastery of the task has been met.

F (24) Allow for individual variation in physical coordination and provide extra time and practice for those who learn the skills less readily.

F (25) Reduce forgetting by providing periodic practice for infrequently used skills.

LEARNING GUIDELINES

Behavioral Category #8 - Steering and Guiding/Continuous Movement

P (1) Critical cues, from which the trainee gets feedback on how well the task was performed, must be realistic and continually available during the performance of the task.

P (2) In continuous control task training, maintain a high level of real world conditions in the presentation of cues to which the trainee must react, the actions and reactions which the trainee makes, and the way that the displays and controls of the system continuously respond to the trainee's control.

P/F (3) Demonstrate correct task performance with a model.

P/F (4) Provide practice under a variety of conditions.

P/F (5) Provide practice on specific component skills when learning complex tasks.

P/F (6) Give the student knowledge of results on small, distinct segments of his performance, especially during early stages of learning.

P/F (7) Teach the student to scan continuously by specific training of eye movement and where to focus for scanning.

F (8) At the beginning of the training, the instructor or the materials should clearly inform the trainee of the learning objectives.

F (9) Relate the learning objectives and activities to operational tasks which the trainee must perform in future real world assignments.

(10) Provide a preview of important, selected motions and movements that the student will learn to make.

F (11) Break the overall learning task down into manageable steps or unit when any of the following conditions exist:

a. lower ability students

b. complex material

c. the overall task contains many small parts and is so long that the student or instructor thinks that only a part of it at a time should be learned.

F (12) Highly skilled performance requires extensive practice; This practice should provide:

a. an understanding of skill objectives

b. the student can observe skill performances

c. the student is given adequate opportunity to practice on the task

d. student receives knowledge of results

e. rest periods to be mixed in with the practice periods when the trainee feels that he needs them.

F (13) Positive reward should be provided for performances which are closer to goal than preceeding performances. In this manner, the student's performance will become successively closer to the desired performance (shaping).

F (14) Positive reward should follow as soon as possible after each correct student performance; initially after each distinct segment of performance and toward the end of training after each maneuver or complete evolution.

P (1) Provide a visual demonstration of the physical skill that the trainee is expected to perform at each step in the checklist of procedures.

P (2) Pick out features of the real world job environment which could be used to spark the trainees' recall of training material which must be used in that part of his job.

P (3) Provide realism for procedural and physical skills practice:

a. equipment realism can be at a minimum level; for example, a photo of the job setting or a paper and plywood model

b. checklist items and their corresponding procedural responses need to be as realistic as possible

P/F (4) Break the physical skills (positioning movement) into logical sub-units or part skills. Then make sure that the procedural steps for each of these sub-units are well organized.

P/F (5) Break the overall learning task down into manageable steps or units when any of the following conditions exist:

a. lower ability students

b. complex material

c. overall task contains many small parts

P/F (6) If the checklist presents the trainee with <u>similar checklist</u> items which in the past have been frequently confused, then

be sure that the trainee can explain the differences between these similar checklist items before he is taught which action to take for each one.

P/F (7) When possible, supply students with diagrams, pictures, charts, graphs, rhymes, acronyms, key words, and other association devices like these to which the student can relate the material he is trying to learn.

- The following (8-13) are guidelines for providing the trainee with practice:

P/F (8) Ensure that the trainee has a lot of opportunity to practice physical skills early in the training.

P/F (9) Be sure the trainee understands the learning objectives.

P/F (10) Provide a visual demonstration of the correct performance

P/F (11) Allow the trainee to practice part-skills and provide feedback to train him to perfect the movement.

P/F (12) Integrate the part-skills into a smooth sequence.

P/F (13) Provide feedback so the trainee can improve his performance.

- The following (14-19) are guidelines for managing earlier stages of training.

P/F (14) Provide immediate and frequent knowledge of results.

P/F (15) Provide immediate and frequent positive reward.

P/F (16) Provide few or no distractions

P/F (17) Learning material should be broken down into small, easily learned parts.

P/F (18) Items should be relatively easy to learn

P/F (19) Provide guides, prompts, cues, and coaching to aid learning.

- The following (20-25) are guidelines for managing <u>later</u> stages of learning.

P/F (20) Provide occasional, delayed feedback.

P/F (21) Provide occasional, delayed reward of students' correct movements.

P/F (22) Distractions and interferance should be similar to what will be found on the job.

P/F (23) Learning material to be recalled and used should be as it would be found on the job.

P/F (24) Learning material should be as complex as that to be used on the job.

P/F (25) Use no guides or prompts that would not be found on the job.

F (26) At the beginning of the training, the instructor or materials/ media should clearly inform the trainee of the learning objectives.

F (27) Organize the training material in such a way that the trainee can easily identify and achieve the learning objectives throughout the training.

F (28) Relate the objectives and learning activities to operational tasks which the trainee must perform in future real world assignments.

F (29) Encourage the students to make up their own association devices if they can.

F (30) When possible, provide students with association devices which will cause an emotional reaction in the student.

F (31) To help students remember a chain of procedures, it is useful to practice identifying checklist items. Some examples are:

a. identifying each checklist item and explaining or performing its corresponding procedure

b. identifying a group of checklist items (as many as the student can handle at once) and explaining or performing their corresponding procedural steps; the first items of each group should overlap with the last items of the previously studied group

c. identifying all of the checklist items and explaining or performing their corresponding procedural steps

d. encourage students to mentally practice running through the steps in the checklist

F (32) Help students to use association devices that are easy to remember, to aid in the recall of procedures.

F (33) Positive reward should follow as soon as possible after a correct answer.

F (34) The pause <u>following</u> knowledge of results should be long enough to allow the student time to sort out his errors or mentally confirm his correct answer, (post-feedback delay).

F (35) Rest periods should be provided during practice sessions according to need for rest as judged by the student (or) requirements of the specific learning material as judged by the instructor.

F (36) Overlearn the task through extensive practice.

F (37) In order for slower learners to reach the same level of proficiency as faster learners, time must be allowed for the slower learner to get as many (or more) positive rewards for correct answers as the faster learner.

F (38) As training continues, occasionally give the learner chances to compare his progress and achievement with the stated course objectives.

F (39) Train the student to the level of proficiency required on the job. Facilitate acquisition of the material by relating it to on-the-job duties, responsibilities, advancement, or survival.

F (40) Reduce forgetting by providing periodic practice for infrequently used procedures.

LEARNING GUIDELINES

Behavioral Category #10 - Voice Communicating

P (1) Break up the presentation material into separate, distinctive types of voice communication that are used on the job.

P (2) Point out critical cues and performances that are different from habitual (everyday type) voice communication.

P/F (3) Identify similar cues (sounds, words, groups of words, vocal patterns, etc.) that are often confused in job communications and test the student to be sure that he can tell the difference between them.

P/F (4) Teach the student to be mentally alert (perceptual set) for the specific voice communications being taught; that is, teach the student to listen for certain words and phrases.

P/F (5) Demonstrate a voice procedure by giving examples of correct performance. Be sure the learner observes critical cues and the appropriate responses that he should make to them.

P/F (6) Toward the end of training, increase stress and miscellaneous interruptions, distractions, and "noise" to the level that will appear on the job.

P/F (7) Toward the end of training, practice voice communication procedures to the level that they will have to be performed in the job setting.

P/F (8) At the beginning of the training, the instructor or the materials should clearly inform the trainee of the learning objectives.

(9) Organize the training material in such a way that the trainee can easily identify and meet the learning objectives.

F (10) Relate the learning objectives and activities to operational tasks which the trainee must perform in future real world assignments.

F (11) Present a brief overview of the activities in which the students will participate during training.

F (12) Before demonstrating specific procedures and techniques, teach general voice communication terminology and procedure.

F (13) Require enough practice trials of the learner to produce the correct performance; he should especially practice parts he is having difficulty with until he can demonstrate the correct procedure.

F (14) During practice, practical applications, and practice tests, provide the student with immediate knowledge of results about his correct and incorrect answers.

F (15) Positive reward should follow as soon as possible after a correct answer.

F (16) Rest periods should be provided during practice sessions according to need for rest as judged by the student and requirements of the specific learning material as judged by the instructor.

F (17) Cross-train the learner so that he may perform other voice communication tasks and be able to act as a replacement for other members of his team.

F (18) Require the student to overlearn the original material; that is, the student should continue to practice the required tasks after the point that simple mastery of the task has been met.

F (19) Reduce forgetting by providing periodic practice for infrequently used material.

F (20) Provide a large reward when trainee meets overall training objectives and required overlearning.